See the possibilities

Elite Series

User Manual

EL-2800M-PMCL
EL-2800C-PMCL

2.8M Digital Progressive Scan Monochrome and Color Camera

Document Version: 1.5
EL-2800-PMCL_Ver.1.5_Oct2013

1043E-1302

Notice

The material contained in this manual consists of information that is proprietary to JAI Ltd., Japan and may only be used by the purchasers of the product. JAI Ltd., Japan makes no warranty for the use of its product and assumes no responsibility for any errors which may appear or for damages resulting from the use of the information contained herein. JAI Ltd., Japan reserves the right to make changes without notice.

Company and product names mentioned in this manual are trademarks or registered trademarks of their respective owners.

Warranty

For information about the warranty, please contact your factory representative.

Certifications

CE compliance

As defined by the Directive 2004/108/EC of the European Parliament and of the Council, EMC (Electromagnetic compatibility), JAI Ltd., Japan declares that EL-2800M-PMCL and EL-2800C-PMCL comply with the following provisions applying to its standards.
EN 61000-6-3 (Generic emission standard part 1)
EN 61000-6-2 (Generic immunity standard part 1)

FCC

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

1. Reorient or relocate the receiving antenna.
2. Increase the separation between the equipment and receiver.
3. Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
4. Consult the dealer or an experienced radio/TV technician for help.

Warning

Changes or modifications to this unit not expressly approved by the party responsible for FCC compliance could void the user's authority to operate the equipment.

Supplement

The following statement is related to the regulation on " Measures for the Administration of the control of Pollution by Electronic Information Products " , known as " China RoHS ". The table shows contained Hazardous Substances in this camera.

mark shows that the environment-friendly use period of contained Hazardous Substances is 15 years.

重要注意事项

有毒，有害物质或元素名称及含量表

根据中华人民共和国信息产业部『电子信息产品污染控制管理办法』，本产品《 有毒，有害物质或元素名称及含量表 》如下.

部件名称	有毒有害物质或元素					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PPB)	多溴二苯醚 (PBDE)
螺丝固定座	×	○	○	○	○	○
连接插头	×	○	○	○	○	○
电路板	×	○	○	○	○	○
.....	.....	.....	.....	.....	.....	.....

○: 表示该有毒有害物质在该部件所有均质材料中的含量均在SJ/T11363-2006规定的限量要求以下。
×: 表示该有毒有害物质至少在该部件的某一均质材料中的含量超出SJ/T11363-2006规定的限量要求。
（企业可在此处、根据实际情况对上表中打 " × " 的技术原因进行进一步说明。）

环保使用期限

电子信息产品中含有的有毒有害物质或元素在正常使用的条件下不会发生外泄或突变、电子信息产品用户使用该电子信息产品不会对环境造成严重污染或对基人身、财产造成严重损害的期限。

数字「15」为期限15年。

Supplement

The following statement is related to the regulation on " Measures for the Administration of the control of Pollution by Electronic Information Products " , known as " China RoHS ". The table shows contained Hazardous Substances in this camera.

mark shows that the environment-friendly use period of contained Hazardous Substances is 15 years.

重要注意事项

有毒，有害物质或元素名称及含量表

根据中华人民共和国信息产业部『电子信息产品污染控制管理办法』，本产品《 有毒，有害物质或元素名称及含量表 》如下.

部件名称	有毒有害物质或元素					
	铅（Pb）	汞（Hg）	镉（Cd）	六价铬（Cr(VI)）	多溴联苯（PPB）	多溴二苯醚（PBDE）
螺丝固定座	×	○	○	○	○	○
光学滤色镜	×	○	×	○	○	○
连接插头	×	○	○	○	○	○
电路板	×	○	○	○	○	○
…….	…….	…….	…….	…….	…….	…….

○：表示该有毒有害物质在该部件所有均质材料中的含量均在SJ/T11363-2006规定的限量要求以下。
×：表示该有毒有害物质至少在该部件的某一均质材料中的含量超出SJ/T11363-2006规定的限量要求。
（企业可在此处、根据实际情况对上表中打"×"的技术原因进行进一步说明。）

环保使用期限

电子信息产品中含有的有毒有害物质或元素在正常使用的条件下不会发生外泄或突变、电子信息产品用户使用该电子信息产品不会对环境造成严重污染或对基人身、财产造成严重损害的期限。

数字「15」为期限15年。

- Contents -

Before using this manual ..... - 6 -
1. General ..... - 7 -
2. Camera composition ..... - 7 -
3. Main features ..... - 8 -
4. Locations and functions ..... - 9 -
4.1 Locations and functions ..... - 9 -
4.2. Rear Panel ..... - 10 -
5. Input and output ..... - 11 -
5.1 Connectors and pin assignment ..... - 11 -
5.1.1 12-Pin connector ..... - 11 -
5.1.1.1 Figure ..... - 11 -
5.1.1.2 Pin assignment ..... - 11 -
5.1.2 Camera Link connector ..... - 11 -
5.1.2.1 Figure ..... - 11 -
5.1.2.2 Pin assignment ..... - 12 -
5.1.3 AUX Standard Hirose 10-Pin Connector ..... - 12 -
5.1.4 AUX Type 2 Hirose 10-Pin Connector (Factory option) ..... - 13 -
5.1.5 AUX Type 3 Hirose 10-Pin Connector (Factory option) ..... - 13 -
5.2 Camera Link interface ..... - 14 -
5.3 Digital IN/OUIT interface ..... - 15 -
5.3.1 Line Selector ..... - 15 -
5.3.2 Line source ..... - 15 -
5.3.3 Line Mode ..... - 15 -
5.3.4 Line Inverter ..... - 15 -
5.3.5 Line Status ..... - 16 -
5.3.6 Line Format ..... - 16 -
5.3.7 GPIO ..... - 16 -
5.4 Pulse Generator ..... - 17 -
5.4.1 Clock Pre-scaler ..... - 18 -
5.4.2 Pulse Generator Selector ..... - 18 -
5.4.3 Pulse Generator Length ..... - 19 -
5.4.4 Pulse Generator Start Point ..... - 19 -
5.4.5 Pulse Generator End Point ..... - 19 -
5.4.6 Pulse Generator Repeat Count ..... - 19 -
5.4.7 Pulse Generator Clear Activation ..... - 19 -
5.4.8 Pulse Generator Clear Sync Mode ..... - 19 -
5.4.9 Pulse Generator Clear Source ..... - 21 -
5.4.10 Pulse Generator Inverter ..... - 22 -
5.4.11 Pulse Generator Setting table ..... - 22 -
6. Sensor layout, output format and timing ..... - 23 -
6.1 Sensor layout ..... - 23 -
6.1.1 Monochrome sensor ..... - 23 -
6.1.2 Bayer color sensor ..... - 23 -
6.2. Camera output format ..... - 24 -
6.2.1 1X-1Y ..... - 24 -
6.2.2 1X-2YE ..... - 24 -
6.2.3 1X2-1YE ..... - 25 -
6.2.4 1X2-2YE ..... - 25 -
6.3 Output timing ..... - 26 -
6.3.1 Horizontal timing ..... - 26 -
6.3.1.1 Output format 1X2-2YE , 1X2-1Y ..... - 26 -
6.3.1.2 Output format 1X-2YE , 1X-1Y ..... - 26 -

6.3.2 Vertical timing ..... - 27 -
6.3.2.1 Output format 1X2-2YE , 1X-2YE ..... - 27 -
6.3.2.2 Output format 1X2-1Y , 1X-1Y ..... - 28 -
6.3.3 ROI (Region Of Interest) ..... - 28 -
6.4 Digital output bit allocation ..... - 29 -
7. Operating modes ..... - 29 -
7.1. Acquisition control (change the frame rate) ..... - 29 -
7.1.1 Acquisition frame rate ..... - 29 -
7.1.2 Calculation of default frame rate ..... - 30 -
7.2. Exposure control ..... - 30 -
7.2.1 Exposure Mode ..... - 30 -
7.2.2 Exposure Time ..... - 31 -
7.2.3 Exposure Auto ..... - 31 -
7.3. Trigger Mode ..... - 32 -
7.3.1 Trigger Source ..... - 32 -
7.3.2 Trigger Activation ..... - 32 -
7.3.3 Trigger Overlap ..... - 32 -
7.3.4 Trigger Delay ..... - 32 -
7.4. Normal continuous operation (Timed Exposure Mode/Trigger Mode OFF) ..... - 32 -
7.5. Timed (EPS) mode ..... - 33 -
7.5.1 If the overlap setting is lse i ..... - 33 -
7.5.2 If the overlap setting is lse is 54 ..... - 34 -
7.6. Trigger Width mode ..... - 34 -
7.6.1 If the overlap setting is lse (..... - 35 -
7.6.2 If the overlap setting is lse (1X24 ..... - 36 -
7.7. RCT mode ..... - 36 -
7.8. PIV (Particle Image Velocimetry) ..... - 37 -
7.9. Sequential Trigger ..... - 38 -
7.9.1 Video send mode ..... - 38 -
7.9.2 Sequence ROI setting parameters ..... - 39 -
7.10. Operation and function matrix ..... - 42 -
8. Other functions ..... - 43 -
8.1 Black level control ..... - 43 -
8.1.1 Black Level Selector ..... - 43 -
8.1.2 Black Level ..... - 43 -
8.1.3 Black Level Auto ..... - 43 -
8.2 Gain control ..... - 44 -
8.2.1 Gain Selector ..... - 44 -
8.2.2 Gain ..... - 44 -
8.2.3 Gain Raw ..... - 45 -
8.2.4 Gain Auto ..... - 45 -
8.2.5 Balance White Auto ..... - 46 -
8.3. LUT ..... - 46 -
8.3.1 LUT Enable ..... - 46 -
8.3.2 LUT Index ..... - 46 -
8.3.3 LUT value ..... - 46 -
8.4. Gamma ..... - 47 -
8.5. Shading Correction ..... - 47 -
8.6. Blemish compensation ..... - 48 -
8.7. Bayer color interpolation (Only for EL-2800C) ..... - 49 -
8.8 Lens ..... - 49 -
8.8.1 About P-Iris ..... - 50 -
8.8.2 Setting for P-iris lens being used ..... - 50 -
8.8.2.1 P-Iris lens select ..... - 50 -

8.8.2.2 Step max. - 50 -
8.8.2.3 Position - 50 -
8.8.2.4 Current F value - 50 -
8.8.2.5 P-Iris Auto min. / P-Iris Auto max. - 50 -
8.8.2.6 Auto Iris Lens Control Signal Output - 50 -
8.8.3 Motorized lenses - 51 -
8.8.3.1 Iris - 51 -
8.8.3.2 Zoom - 51 -
8.8.3.3 Focus+ - 51 -
8.8.4 Exclusive video output signal for iris control - 51 -
8.9 ALC - 52 -
9. Camera Control Tool - 53 -
10. External appearance and dimensions - 54 -
11. Specifications - 55 -
11.1 Spectral response - 55 -
11.2 Specifications table - 56 -
Appendix 1 Short ASCII Command Communication Protocol - 58 -
1. Communication setting - 58 -
2. Protocol（Short ASCII Command） - 58 -
2.1 Transmit the setting command to camera - 58 -
2.2 Transmit the request command to camera - 58 -
2.3 Switching baud rate between PC and camera - 59 -
2.4 Command list (Short ASCII command) - 59 -
2.4.1 GenCP Bootstrap Register - 59 -
2.4.2 Technology Specific Bootstrap Register - 60 -
2.4.3 Device Control - 60 -
2.4.4 Image Format Control - 61 -
2.4.5 Acquisition Control - 62 -
2.4.6 Digital I/O Control - 62 -
2.4.7 Analog Control - 64 -
2.4.8 LUT Control - 66 -
2.4.9 Transport Layer Control - 66 -
2.4.10 User Set Control - 66 -
2.4.11 JAI-Custom - 67 -
Appendix 2 - 82 -
1. Precautions - 82 -
2. Typical Sensor Characteristics - 82 -
3. Caution when mounting a lens on the camera - 82 -
4. Caution when mounting the camera - 83 -
5. Exportation - 83 -
6. References - 83 -
Manual change history - 84 -
User's Record - 85 -

Before using this manual

EMVA 1288

With regard to signal to noise ratio in this manual, specifications measured by EMVA 1288 are used together with specifications by a traditional measurement method.

EMVA 1288 is a more complete measurement that considers multiple noise sources, including random noise, pattern noise, and shading. Additionally, EMVA 1288 incorporates temporal variances in pixel output by capturing 100 frames of data and computing the RMS variations over the captured frames. Because of the comprehensive nature of the noise analysis and the additional consideration for RMS variances over time, EMVA 1288 SNR measurements are inherently lower than the traditional SNR measurements given by manufacturers. However, the comprehensive nature combined with rigid test parameters, means that all manufacturers' are measuring their products equally and EMVA 1288 tested parameters can be compared among different manufacturers' products.

In order to learn more about EMVA 1288, please visit http://www.emva.org

Frame grabber board

The EL-2800-PMCL complies with "Power over Camera Link" which enables power to be supplied to the camera through the Camera Link cable(s). Because the power requirements of the camera exceed the amount of power which can be provided over a single PoCL connection, power must be supplied via both Camera Link cables in order to utilize the PoCL capabilities. If you plan to use this function, please be sure that the frame grabber board you are using also complies with this specification. Alternatively, the camera can be powered via a separate power supply connected to the 12-pin Hirose connector.

1. General

The EL-2800M-PMCL and EL-2800C-PMCL are the first new Elite Series cameras to be introduced. They provide high picture quality, such as high sensitivity and low noise, suitable for machine vision applications. The EL-2800M-PMCL is a monochrome progressive scan CCD camera and the EL-2800C-PMCL is the equivalent Bayer mosaic progressive scan CCD camera. Both are equipped with a 2/3-inch CCD sensor offering 2.83 million pixels resolution and a 4:3 aspect ratio. They provide 54.7 frames per second for continuous scanning with 1920 x 1440 full pixel resolution for both monochrome and raw Bayer output.

8-bit, 10-bit or 12-bit output can be selected for both monochrome and Bayer outputs. The EL-2800C-PMCL is also capable of performing in-camera color interpolation to produce 24-bit (8-bit per color) RGB output at 15.8 fps. Video output is via a Mini Camera Link interface supporting both Base and Medium configurations. A full pixel readout, partial scan readout, or binning mode (monochrome only) can be selected depending on the application.

EL-2800M-PMCL and EL-2800C-PMCL have various comprehensive functions needed for automated optical inspection applications, such as solid state device inspection or material surface inspection. They incorporate video processing functions such as a look-up table, flat field shading compensation and blemish compensation in addition to fundamental functions such as trigger, exposure setting and video level control.

As a common Elite Series feature, a new connector for lens control is employed. EL-2800M-PMCL and EL-2800C-PMCL support P-iris and motor-driven lenses as standard lens control capabilities. Factory options are available to configure this connector to support DC iris systems as well as provide a video iris output signal, or to provide additional TTL IN and OUT lines.

The latest version of this manual can be downloaded from: www.jai.com
The latest version of the Camera Control Tool for the EL-2800M-PMCL and EL-2800C-PMCL can be downloaded from: www.jai.com
For camera revision history, please contact your local JAI distributor.

2. Camera composition

The standard camera composition is as follows.

Camera body	1
Sensor protection cap	1
Dear Customer (sheet)	1

The following optional accessories are available.

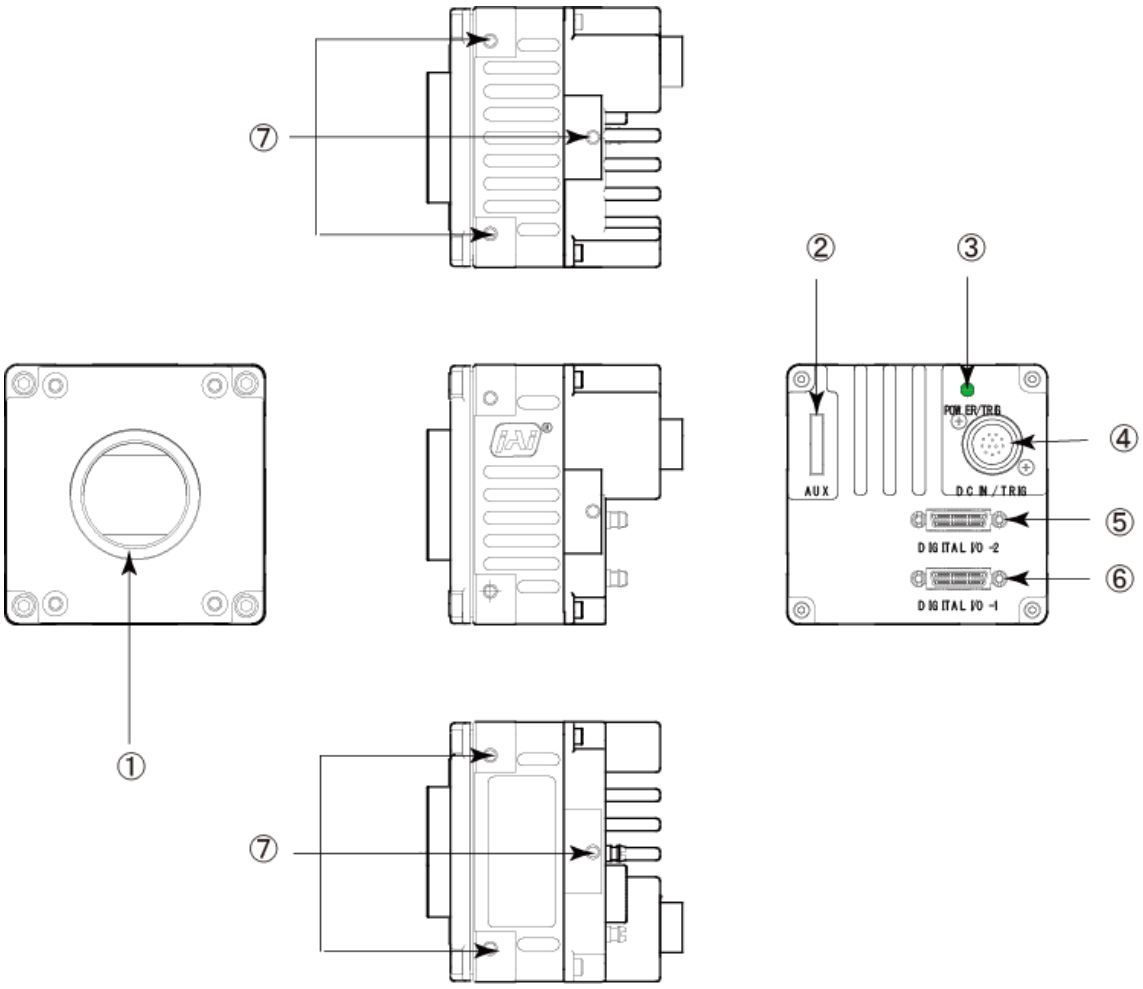
Tripod base	MP-42
Power supply unit	PD-12 series

3. Main features

- New Elite Series, 2/3 ” progressive scan camera
- Utilizes Mini Camera Link interface with Base and Medium configurations
- Aspect ratio 4:3, 1920 (h) x 1440 (v), 2.8 million effective pixels
- 4.54 μm square pixels
- S/N 61dB for monochrome and 58.5 dB for color (traditional measurement)
- 8-bit, 10-bit or 12-bit output for monochrome and Bayer or 8-bit per color output for RGB color
- 54.7 frames/second with full resolution in continuous operation for 4-tap output (monochrome or Bayer), 15.8 frames/second for 1-tap output (RGB output in-camera interpolation))
- Various readout modes, including horizontal and vertical binning (EL-2800M-PMCL only) and ROI (Region Of Interest) for faster frame rates
- 0dB to +30dB gain control for EL-2800M-PMCL and 0dB to +27dB for EL-2800C-PMCL
- 10 μs (1/100,000) to 8 seconds exposure control in 1 μs step
- Auto exposure control
- Timed and trigger width exposure control,
- RCT, PIV and sequential trigger modes for specific applications
- ALC control with combined function of AGC, auto exposure and auto iris
- Various pre-processing circuits are provided
  - Programmable LUT
  - Gamma correction from 0.45 to 1.0
  - Flat field correction
  - Bayer white balance with manual or one-push auto (EL-2800C-PMCL only)
  - Bayer color interpolation (EL-2800C-PMCL only)
  - Blemish compensation
- Auto iris lens video output with H-sync
- New Hirose 10P connector for lens interface including P-Iris lens control
- C-mount for lens mount
- Setup by Windows XP/Vista/7 via serial communication

4. Locations and functions

4.1 Locations and functions



①	Lens mount	C-mount (Note *1)
②	10-pin AUX connector	Standard (Connector for lens control)
③	LED	Indication for power and trigger input
④	12-pin connector	DC+12V and trigger input
⑤	Camera Link Connector 2	Digital video output (Medium configuration) (Note *2)
⑥	Camera Link Connector 1	Digital video output (Base configuration) (Note *2)
⑦	Mounting hole	M3 depth 5 mm for fixing the camera to the mount plate or tripod mount plate (Note *3)

*1) Note: Rear protrusion on C-mount lens must be less than 10.0 mm.
*2) Note: When a Camera Link cable is connected to the camera, please do not excessively tighten screws by using a driver. The Camera Link receptacle on the camera might be damaged. For security, the strength to tighten screws is less than 0.147 Newton meter (Nm). Tightening by hand is sufficient in order to achieve this.
*3) Note: The part number for the tripod adapter plate (with 1/4"-20 thread) is MP-42 (option).

Fig. 1 Locations

4.2. Rear Panel

The rear panel mounted LED provides the following information:

● Amber: Power connected – initiating
This light goes OFF after initiating.
● Steady green: Camera is operating in Continuous mode
❋ Flashing green: The camera is receiving external triggering

Note: The interval of flashing does not correspond with external trigger duration.

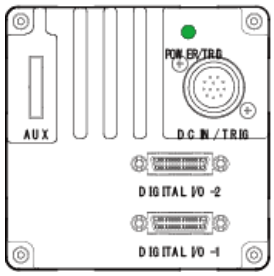


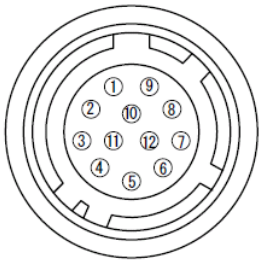
Fig. 2 Rear panel

5. Input and output

5.1 Connectors and pin assignment

5.1.1 12-Pin connector

5.1.1.1 Figure



Type: HR10A-10R-12PB-01 (Hirose) male or equivalent.
Use the part number HR10A-10P-12S for the cable side

Fig.3 Hirose 12-pin connector

5.1.1.2 Pin assignment

Table – 1 12P pin assignment

Pin no.	Signal	Remarks
1	GND	
2	DC input	+12V to +24V
3	GND	
4	Iris video	Exclusive video output for auto iris
5	NC	
6	NC	
7	NC	
8	NC	
9	TTL out 1	Line 1 (Note*1)
10	TTL In 1	Line 4 (Note*2)
11	DC input	+12V to +24V
12	GND	

*1) Factory default setting is an Exposure Active signal with negative polarity.
*2) Factory default setting is a trigger input

5.1.2 Camera Link connector

5.1.2.1 Figure

Type: 26-pin Mini Camera Link Connector (Honda HDR-EC26FYTG2-SL+)

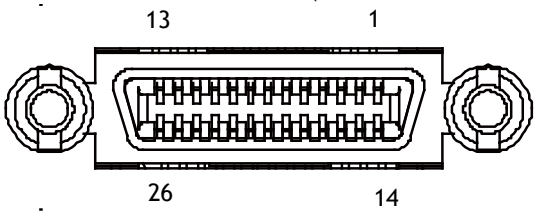


Fig.4 Camera Link connector

5.1.2.2 Pin assignment

Table – 2 Camera Link connector 1 Pin assignment

Pin No	In/Out	Name	Note
1,26		Power	Power
2(-),15(+)	O	TxOUT0	Data out
3(-),16(+)	O	TxOUT1	
4(-),17(+)	O	TxOUT2	
5(-),18(+)	O	TxClk	Clock for CL
6(-),19(+)	O	TxOUT3	Data out
7(+),20(-)	I	SerTC (RxD)	LVDS Serial Control
8(-),21(+)	O	SerTFG (TxD)	
9(-),22(+)	I	CC1 (Trigger)	Trigger IN
10(+),23(-)		N.C	
11,24		N.C	
12,25		N.C	
13,14		Shield	Power return

Table – 3 Camera Link connector 2 pin assignment

Pin No	In/Out	Name	Note
1,26		Power	Power
2(-),15(+)	O	TxOUT0	Data out
3(-),16(+)	O	TxOUT1	
4(-),17(+)	O	TxOUT2	
5(-),18(+)	O	TxClk	Clock for CL
6(-),19(+)	O	TxOUT3	Data out
7(+),20(-)	I	N.C	
8(-),21(+)	O	N.C	
9(-),22(+)	I	N.C	
10(+),23(-)		N.C	
11,24		N.C	
12,25		N.C	
13,14		Shield	Power return

5.1.3 AUX Standard Hirose 10-Pin Connector

Type : HIROSE 10-Pin Connector 3260-10S3(55)

Fig.5 Hirose 10P connector

Table – 4 AUX Standard Hirose 10P connector pin assignment

No	I/O	Name	Note
1	O	DRIVE IRIS+	Motorized Lens
2	O	DRIVE FOCUS+	Motorized Lens
3	O	DRIVE ZOOM+	Motorized Lens
4	O	COMMON	Motorized Lens
5		GND	
6	O	P-IRIS OUT1A	P-Iris Lens
7	O	P-IRIS OUT1B	P-Iris Lens
8	O	P-IRIS OUT2A	P-Iris Lens
9	O	P-IRIS OUT2B	P-Iris Lens
10	O	GND	

5.1.4 AUX Type 2 Hirose 10-Pin Connector (Factory option)

HIROSE 10-Pin Connector 3260-10S3(55)
Note: This is a factory option.

Table – 5 AUX connector Type 2 pin assignment

No	I/O	Name	Note
1	O	Video Signal	Video Iris Lens
2	O	Power DC+12V	Video Iris Lens
3		NC	
4		NC	
5		GND	
6	O	DC IRIS DAMP-	DC Iris
7	O	DC IRIS DAMP+	DC Iris
8	O	DC IRIS DRIVE+	DC Iris
9	O	DC IRIS DRIVE-	DC Iris
10		GND	

5.1.5 AUX Type 3 Hirose 10-Pin Connector (Factory option)

HIROSE 10-Pin Connector 3260-10S3(55)
Note: This is a factory option.

Table – 6 AUX connector Type 3 pin assignment

No	I/O	Name	Note
1	O	TTL OUT2	Line8
2	O	TTL OUT3	Line9
3	I	TTL_IN2	Line10
4		NC	
5		GND	
6	I	LVDS_IN1+	Line11
7	I	LVDS_IN1-	
8		NC	
9		GND	
10		GND	

5.2 Camera Link interface

Table – 7 Camera Link interface

EL-2800M/C-PMCL						
Port	Camera Link Configuration		Base		Medium	Base
	Camera Link port/bit		1Tap / 12bit	2ap / 12bit	4 Tap / 12bit	1 Tap / 8bit
	GenICam Tap Geometry		1X1 - 1Y	1X - 2YE/1X2-1Y	1x2 - 2YE	RGB
Digital I/O-1	Port A0	TxIN 0	Tap1 D0	Tap 1 D0	Tap 1 D0	RD 0
	Port A1	TxIN 1	Tap1 D1	Tap 1 D1	Tap 1 D1	RD 1
	Port A2	TxIN 2	Tap1 D2	Tap 1 D2	Tap 1 D2	RD 2
	Port A3	TxIN 3	Tap1 D3	Tap 1 D3	Tap 1 D3	RD 3
	Port A4	TxIN 4	Tap1 D4	Tap 1 D4	Tap 1 D4	RD 4
	Port A5	TxIN 6	Tap1 D5	Tap 1 D5	Tap 1 D5	RD 5
	Port A6	TxIN 27	Tap1 D6	Tap 1 D6	Tap 1 D6	RD 6
	Port A7	TxIN 5	Tap1 D7	Tap 1 D7	Tap 1 D7	RD 7
	Port B0	TxIN 7	Tap1 D8	Tap 1 D8	Tap 1 D8	G D2
	Port B1	TxIN 8	Tap1 D9	Tap 1 D9	Tap 1 D9	G D3
	Port B2	TxIN 9	Tap1 D10	Tap 1 D10	Tap 1 D10	G D4
	Port B3	TxIN 12	Tap1 D11	Tap 1 D11	Tap 1 D11	G D5
	Port B4	TxIN 13		Tap 2 D8	Tap 2 D8	G D6
	Port B5	TxIN 14		Tap 2 D9	Tap 2 D9	G D7
	Port B6	TxIN 10		Tap 2 D10	Tap 2 D10	G D8
	Port B7	TxIN 11		Tap 2 D11	Tap 2 D11	G D9
	Port C0	TxIN 15		Tap 2 D0	Tap 2 D0	B D2
	Port C1	TxIN 18		Tap 2 D1	Tap 2 D1	B D3
	Port C2	TxIN 19		Tap 2 D2	Tap 2 D2	B D4
	Port C3	TxIN 20		Tap 2 D3	Tap 2 D3	B D5
	Port C4	TxIN 21		Tap 2 D4	Tap 2 D4	B D6
	Port C5	TxIN 22		Tap 2 D5	Tap 2 D5	B D7
	Port C6	TxIN 16		Tap 2 D6	Tap 2 D6	B D8
	Port C7	TxIN 17		Tap 2 D7	Tap 2 D7	B D9
	-	TxIN 24	LVAL	LVAL	LVAL	LVAL
	-	TxIN 25	FVAL	FVAL	FVAL	FVAL
	(Port I0)	TxIN 26	DVAL	DVAL	DVAL	DVAL
	(Port I1)	TxIN 23	Exposure Active	Exposure Active	Exposure Active	Exposure Active

EL-2800M/C-PMCL						
Port	Camera Link Configuration		Base		Medium	Base
	Camera Link port/bit		1Tap / 12bit	2ap / 12bit	4 Tap / 12bit	1 Tap / 8bit
	GenICam Tap Geometry		1X1 - 1Y	1X - 2YE/1X2-1Y	1x2 - 2YE	RGB
Digital I/O-2 (1/2)	Port D0	TxIN 0	–	–	Tap 4 D0	–
	Port D1	TxIN 1	–	–	Tap 4 D1	–
	Port D2	TxIN 2	–	–	Tap 4 D2	–
	Port D3	TxIN 3	–	–	Tap 4 D3	–
	Port D4	TxIN 4	–	–	Tap 4 D4	–
	Port D5	TxIN 6	–	–	Tap 4 D5	–
	Port D6	TxIN 27	–	–	Tap 4 D6	–
	Port D7	TxIN 5	–	–	Tap 4 D7	–
	Port E0	TxIN 7	–	–	Tap 3 D0	–
	Port E1	TxIN 8	–	–	Tap 3 D1	–
	Port E2	TxIN 9	–	–	Tap 3 D2	–
	Port E3	TxIN 12	–	–	Tap 3 D3	–
	Port E4	TxIN 13	–	–	Tap 3 D4	–
	Port E5	TxIN 14	–	–	Tap 3 D5	–
	Port E6	TxIN 10	–	–	Tap 3 D6	–
	Port E7	TxIN 11	–	–	Tap 3 D7	–
	Port F0	TxIN 15	–	–	Tap 3 D8	–
	Port F1	TxIN 18	–	–	Tap 3 D9	–
	Port F2	TxIN 19	–	–	Tap 3 D10	–
	Port F3	TxIN 20	–	–	Tap 3 D11	–
	Port F4	TxIN 21	–	–	Tap 4 D8	–
	Port F5	TxIN 22	–	–	Tap 4 D9	–
	Port F6	TxIN 16	–	–	Tap 4 D10	–
	Port F7	TxIN 17	–	–	Tap 4 D11	–
	-	TxIN 24	–	–	LVAL	–
	(Port I2)	TxIN 25	–	–	FVAL	–
	(Port I3)	TxIN 26	–	–	DVAL	–
	(Port I4)	TxIN 23	–	–	Exposure Active	–

5.3 Digital IN/OUIT interface

In the EL-2800 the software control tool can assign the necessary signals to the digital I/O ports.

5.3.1 Line Selector

In the Line Selector, the following input and output signals can be assigned.
Line 1 TTL Out 1
Line 7 TTL In 1
Line 8 TTL Out 2
Line 9 TTL Out 3
Line 11 LVDS In
Note: Lines 8, 9 and 11 are only available if Option 2 for AUX connector is selected.

Table – 8 Line selector

Line Selector item	Description
Line 1 TTL 1 Out	TTL 1 output from # 9 pin of HIROSE 12 Pin on the rear
Line 8 TTL 2 Out	TTL 2 output from #1 pin of AUX connector on the rear
Line 9 TTL 3 Out	TTL 2 output from #2 pin of AUX connector on the rear
NAND 0 In 1	First input to a first gate of NAND
NAND 0 In 2	Second input to a first gate of NAND
NAND 1 In 1	First input to a second gate of NAND
NAND 1 In 2	Second input to a second gate of NAND

5.3.2 Line source

Line source signal can be selected from the following table to connect it to the line item which is selected in the line selector.

Table-9 Line Source

Line Source item	Description
Low	Connect Low Level signal to line item selected in Line Selector, **Default setting**
High	Connect Low High signal to line item selected in Line Selector
Frame Trigger Wait	Connect Frame Trigger Wait signal to line item selected in Line Selector
Frame Active	Connect Frame Active signal to line item selected in Line Selector
Exposure Active	Connect Exposure Active signal to line item selected in Line Selector
FVAL	Connect FVAL signal to line item selected in Line Selector
LVAL	Connect LVAL signal to line item selected in Line Selector
PulseGenerator0 Out	Connect Pulse Generator 0 signal to line item selected in Line Selector
PulseGenerator1 Out	Connect Pulse Generator 1 signal to line item selected in Line Selector
PulseGenerator2 Out	Connect Pulse Generator 2 signal to line item selected in Line Selector
PulseGenerator3 Out	Connect Pulse Generator 3 signal to line item selected in Line Selector
TTL 1 In	Connect TTL 1 IN signal to line item selected in Line Selector
CL CC1 In	Connect CL CC1 IN signal to line item selected in Line Selector
Nand0 Out	Connect NAND 0 signal to line item selected in Line Selector
Nand1 Out	Connect NAND 1 signal to line item selected in Line Selector
Line 10 TTL 2 In	Connect TTL 2 IN signal to Line 10 (Factory option)
Line 11 LVDS 1 In	Connect LVDS 1 IN signal to Line 11 (Factory option)

Note) As for LVAL, some line items cannot be connected. Refer to "5.4.6.2 GPIO matrix table"

5.3.3 Line Mode

Indicates the status of the interface, input or output.

5.3.4 Line Inverter

Sets the polarity of the selected input or output. (False=Positive, True=Negative)

5.3.5 Line Status

Indicates the status of the selected signal, input or output (True=High or False=Low)

5.3.6 Line Format

Indicates the current interface of the selected line item, input or output.

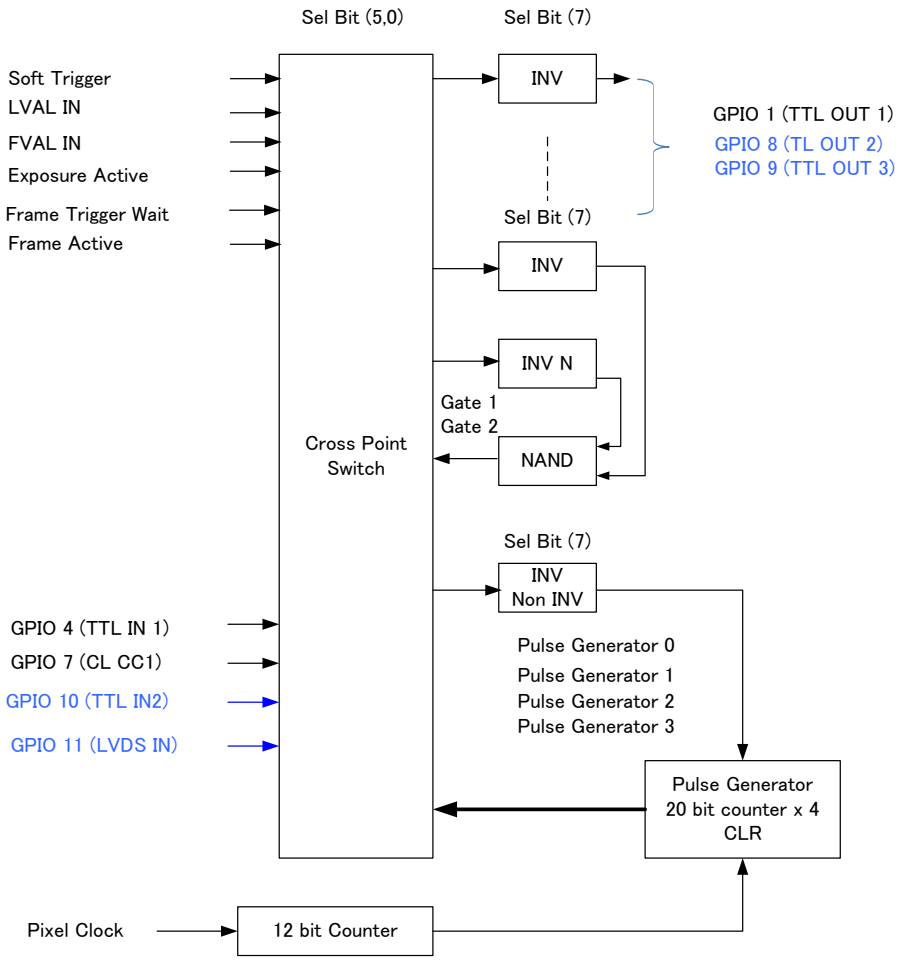
Input	CC1 In	Line 4
	TTL In 1	Line 7
Output	TTL Out1	Line 1

5.3.7 GPIO

This is a general interface for input and output and controls input and output for trigger signals or valid signals and pulse generators. By using this interface, you can control an external light source, make a delayed function to input a trigger signal or make a precise exposure control with PWC trigger.

Basic block diagram is as follows.

EL-2800M/C-PMCL GPIO



Pixel Clock is 54 MHz.

I/F written in blue letters is available if AUX Type 3 is selected.

Fig.6 GPIO interface

The following table shows the input and output matrix.

Table – 10 GPIO input and output matrix

Selector (Cross Point Switch Output) / Source Signal (Cross Point Switch Input)	Trigger Selector	Line Selector							Pulse Generator Selector			
	Trigger Source (Frame Start Trig Source)	LS0 Line1 - 12Pin TTL Out	LS1 Line 8 - TTL 2 Out(※)	LS2 Line 9 - TTL 3 Out(※)	ND0IN1 NAND 0 In 1	ND0IN2 NAND 0 in 2	ND1IN1 NAND 1 In 1	ND1IN2 NAND 1 in 2	PGIN0 Pulse Generator 0	PGIN1 Pulse Generator 1	PGIN2 Pulse Generator 2	PGIN3 Pulse Generator 3
Low	○	○	○	○	○	○	○	○	○	○	○	○
HIGH	○	○	○	○	○	○	○	○	○	○	○	○
Soft Trigger	○											
Frame Trigger Wait		○	○	○	○	○	○	○	○	○	○	○
Frame Active		○	○	○	○	○	○	○	○	○	○	○
Exposure Active		○	○	○	○	○	○	○	○	○	○	○
FVAL		○	○	○	○	○	○	○	○	○	○	○
LVAL		○	○	○					○	○	○	○
PulseGenerator0	○	○	○	○	○	○	○	○		○	○	○
PulseGenerator1	○	○	○	○	○	○	○	○	○		○	○
PulseGenerator2	○	○	○	○	○	○	○	○	○	○		○
PulseGenerator3	○	○	○	○	○	○	○	○	○	○	○	
TTL_In1	○	○	○	○	○	○	○	○	○	○	○	○
CL_CC1_In	○	○	○	○	○	○	○	○	○	○	○	○
Nand0 Out	○	○	○	○			○	○	○	○	○	○
Nand1 Out	○	○	○	○	○	○			○	○	○	○
Line 10 - TTL 2 In (※)	○	○	○	○	○	○	○	○	○	○	○	○
Line 11 - LVDS 1 In(※)	○	○	○	○	○	○	○	○	○	○	○	○
	Trigger Source	Line Source							Pulse Generator Clear Source			

Note: Items with (※) are available if AUX Type 3 is selected.

5.4 Pulse Generator

The EL-2800M/C-PMCL has a frequency divider using the pixel clock as the basic clock and four pulse generators. In each Pulse Generator, various Clear settings are connected to GPIO. The following shows Pulse Generator default settings.

Table - 11 Pulse Generator default settings

Display Name	Value							
Clock Pre-scaler	1							
	Pulse Generator							
Pulse Generator Selector	Length	Start Point	End Point	Repeat Count	Clear Source	Clear Inverter	Clear Activation	Clear Sync Mode
- Pulse Generator 0	1	0	1	0	Off	True	Off	Async Mode
- Pulse Generator 1	1	0	1	0	Off	True	Off	Async Mode
- Pulse Generator 2	1	0	1	0	Off	True	Off	Async Mode
- Pulse Generator 3	1	0	1	0	Off	True	Off	Async Mode

Note:]
When Pulse Generator Repeat Count is set to “0”, the camera is operating in Free Running mode.
However, based on the above default settings (Length=1, Start Point=0 and End Point=1), Pulse Generator stops at High output. Therefore, if Start Point=0 and End Point=1 are configured, Length should be “2” as the minimum active width.

5.4.1 Clock Pre-scaler

Clock pre-scaler (Divide Value) can set the dividing value of the frequency divider (12-bit length) and the pixel clock is used for this. Four built-in pulse generators work by the same clock. In the EL-2800M/C-PMCL, the pixel clock is 54 Mhz.

5.4.2 Pulse Generator Selector

This is where you select one of the 4 pulse generators in order to set or modify its parameters.

Table - 12 Pulse Generator setting

Trigger Selector item	Description
Pulse Generator 0	If Pulse Generator 0 is selected, Length、Start Point、End Point、Repeat Count、Clear Source、Clear Inverter, Clear Activation and Clear Sync Mode of pulse generator 0 are displayed under the selector.
Pulse Generator 1	If Pulse Generator 1 is selected, Length、Start Point、End Point、Repeat Count、Clear Source、Clear Inverter, Clear Activation and Clear Sync Mode of pulse generator 1 are displayed under the selector.
Pulse Generator 2	If Pulse Generator 2 is selected, Length、Start Point、End Point、Repeat Count、Clear Source、Clear Inverter, Clear Activation and Clear Sync Mode of pulse generator 2 are displayed under the selector.
Pulse Generator 3	If Pulse Generator 3 is selected, Length、Start Point、End Point、Repeat Count、Clear Source、Clear Inverter, Clear Activation and Clear Sync Mode of pulse generator 3 are displayed under the selector.

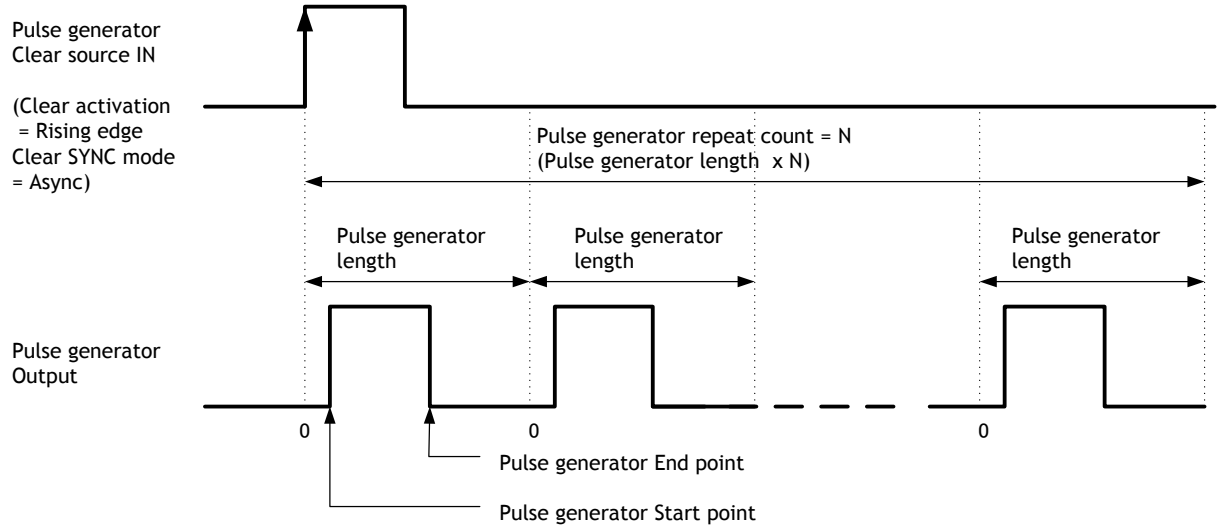


Fig.7 Pulse Generator Pulse construction

5.4.3 Pulse Generator Length

Set the counter up value for the selected pulse generator. If Repeat Count value is "0", and if Pulse Generator Clear signal is not input, the pulse generator generates the pulse repeatedly until reaching this counter up value.

5.4.4 Pulse Generator Start Point

Set the active output start count value for the selected pulse generator.
However, please note that a maximum 1 clock jitter for the clock which is divided in the clock pre-scaler can occur.

5.4.5 Pulse Generator End Point

Set the active output ending count value for the selected pulse generator.

5.4.6 Pulse Generator Repeat Count

Set the repeating number of the pulse for the selected pulse generator. After Trigger Clear signal is input, the pulse generator starts the count set in Repeat Count. Accordingly, an active pulse which has a start point and end point can be output repeatedly.
However, if Repeat Count is set to"0", it works as Free Running counter.

5.4.7 Pulse Generator Clear Activation

Set the clear conditions of clear count pulse for the selected pulse generator.

5.4.8 Pulse Generator Clear Sync Mode

Set the count clear method for the selected pulse generator.
In case of Async Mode, if the clear signal is input during the length setting value, the counter will stop counting according to the clear signal input.
In case of Sync Mode, if the clear signal is input during the length setting value, the counter will continue to count until the end of the length setting value and then clear the count.
Both modes clear the repeat count when the counter is cleared.

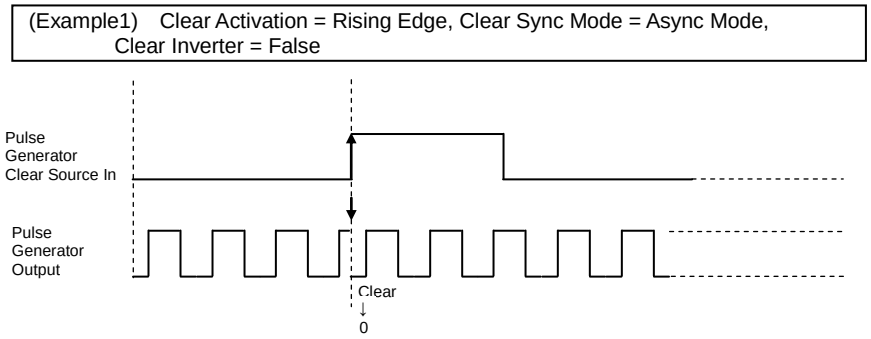


Fig.8 Counter clear in Async mode

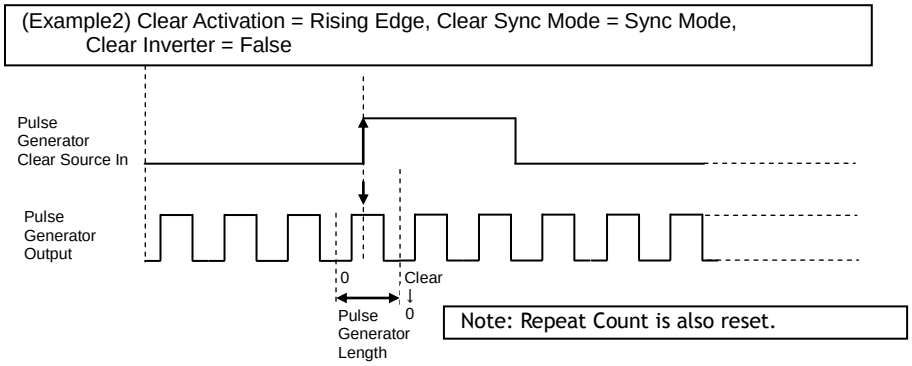


Fig.9 Counter clear in Sync mode

5.4.9 Pulse Generator Clear Source

The following clear source can be selected as the pulse generator clear signal.

Table - 13 Pulse generator clear source

Pulse Generator Clear Source item	Description
Low	Connect Low level signal to Clear Source for the selected pulse generator. **Default setting**
High	Connect High level signal to Clear Source for the selected pulse generator.
Frame Trigger Wait	Connect Frame Trigger Wait signal to Clear Source for the selected pulse generator.
Frame Active	Connect Frame Active signal to Clear Source for the selected pulse generator.
Exposure Active	Connect Exposure Active signal to Clear Source for the selected pulse generator.
FVAL	Connect FVAL signal to Clear Source for the selected pulse generator.
LVAL	Connect LVAL signal to Clear Source for the selected pulse generator.
PulseGenerator0 Out	Connect Pulse Generator 0 output to Clear Source for the selected pulse generator.
PulseGenerator1 Out	Connect Pulse Generator 1 output to Clear Source for the selected pulse generator.
PulseGenerator2 Out	Connect Pulse Generator 2 output to Clear Source for the selected pulse generator.
PulseGenerator3 Out	Connect Pulse Generator 3 output to Clear Source for the selected pulse generator.
TTL 1 In	Connect TTL 1 IN signal to Clear Source for the selected pulse generator.
CL CC1 In	Connect CL CC1 IN signal to Clear Source for the selected pulse generator.
Nand0 Out	Connect NAND 0 output signal to Clear Source for the selected pulse generator.
Nand1 Out	Connect NAND 1 output signal to Clear Source for the selected pulse generator.
Line 10 TTL 2 In	Connect TTL 2 IN signal to LINE 10.
Line 11 LVDS 1 In	Connect LVDS 11 1 IN signal to Line 11

Note:
The pulse generator output cannot be used as the clear input to the same pulse generator. Refer to “5.3.7 GPIO matrix table”.

5.4.10 Pulse Generator Inverter

Clear Source Signal can have polarity inverted.

5.4.11 Pulse Generator Setting table

Table - 14 Pulse Generator setting parameters

Display Name	Value
Clock Pre-scaler	1 to 4096
Pulse Generator Clock (MHz)	[Pixel Clock:54MHz]÷[Clock Pre-scaler]
Pulse Generator Selector	- Pulse Generator 0
	- Pulse Generator 1
	- Pulse Generator 2
	- Pulse Generator 3
- Pulse Generator Length	1 to 1048575
- Pulse Generator Length (ms)	([Clock Source]÷[Clock Pre-scaler])$^{-1}$ x [Pulse Generator Length]
- Pulse Generator Frequency (Hz)	[Pulse Generator Length (ms)]$^{-1}$
- Pulse Generator Start Point	0 to 1048574
- Pulse Generator Start Point (ms)	([Clock Source]÷[Clock Pre-scaler])$^{-1}$ x [Pulse Generator Start Point]
- Pulse Generator End Point	1 to 1048575
- Pulse Generator End Point (ms)	([Clock Source]÷[Clock Pre-scaler])$^{-1}$ x [Pulse Generator End Point]
- Pulse Generator pulse-width (ms)	[Pulse Generator End Point (ms)]－[Pulse Generator Start Point (ms)]
- Pulse Generator Repeat Count	0 to 255
- Pulse Generator Clear Activation Clear Mode for the Pulse Generators	- Off
	- High Level
	- Low level
	- Rising Edge
	- Falling Edge
- Pulse Generator Clear Sync Mode	- Async mode
	- Sync mode
- Pulse Generator Clear Source	- Low
	- High
	- Frame Trigger Wait
	- Frame Active
	- Exposure Active
	- FVAL
	- LVAL
	- PulseGenerator0
	- PulseGenerator1
	- PulseGenerator2
	- PulseGenerator3
	- TTL_In1
	- CL_CC1_In
	- Nand0 Out
	- Nand1 Out
	- Line 10 - TTL 2 In
	- Line 11 - LVDS 1 In
- Pulse Generator Inverter(Polarity) Pulse Generator Clear Inverter	- False
	- True

Note:
1. If Pulse Generator Repeat Count is set to “0”, the pulse generator works in Free Running mode.

6. Sensor layout, output format and timing

6.1 Sensor layout

CCD sensors used in the EL-2800M-PMCL and EL-2800C-PMCL have the following tap and pixel layout.

6.1.1 Monochrome sensor

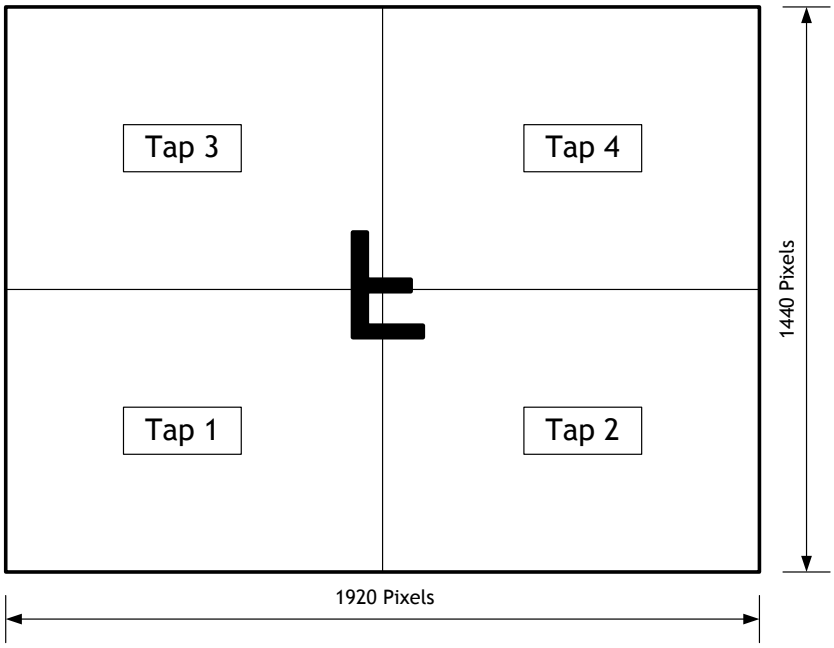


Fig.10 Monochrome sensor layout

6.1.2 Bayer color sensor

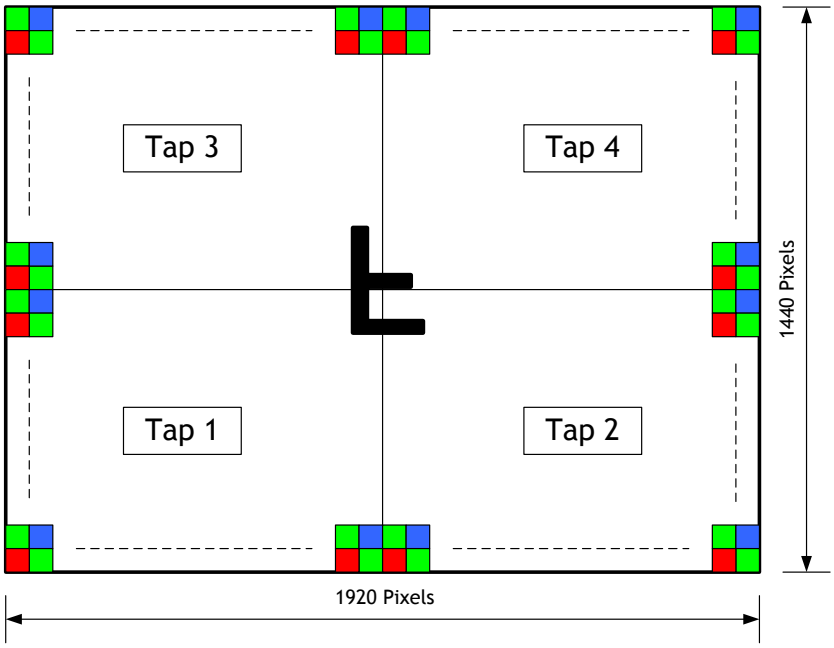


Fig.11 Bayer color sensor layout

6.2. Camera output format

The EL-2800M-PMCL and EL-2800C-PMCL have the following camera output formats described in GenICam SFNC Ver.1.5.1 as Tap Geometry.

Table – 15 Camera output format

Camera output format	Tap geometry	Reference figure
1X-1Y	Single tap	6.2.1
1X-2YE	Dual tap	6.2.2
1X2-1Y	Dual tap	6.2.3
1X2-2YE	Four tap	6.2.4
24-bit RGB (8-bit x 3) (1X-1Y)	Single tap	6.2.1

6.2.1 1X-1Y

1X-1Y is defined in GenICam SFNC Ver.1.5.1 for 1-tap readout and the readout system is the following.

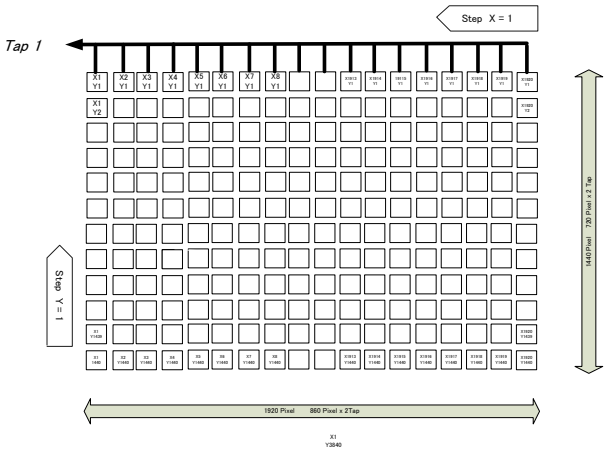


Fig.12 1X-1Y readout

6.2.2 1X-2YE

1X-2YE is for 2-tap readout and the readout system is as follows.

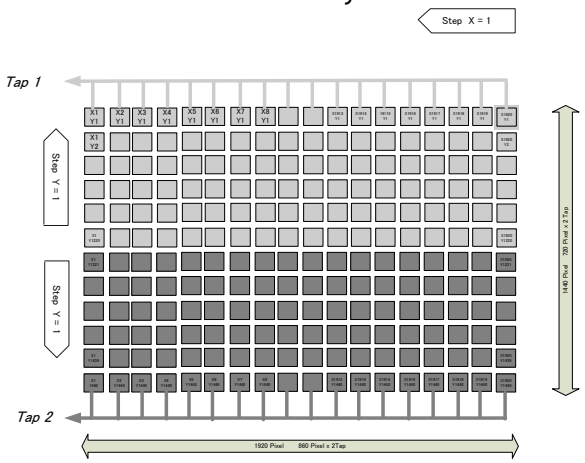


Fig.13 1X-2YE readout

6.2.3 1X2-1YE

1X2-1YE is also for 2-tap readout but the readout system is right and left as below.

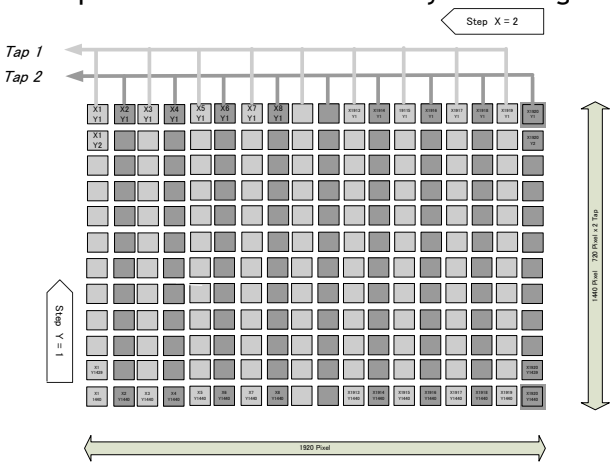


Fig.14 1X2-1YE readout

6.2.4 1X2-2YE

1X2-2YE is 4-tap readout and reads out electronic charges up and down and right and left.

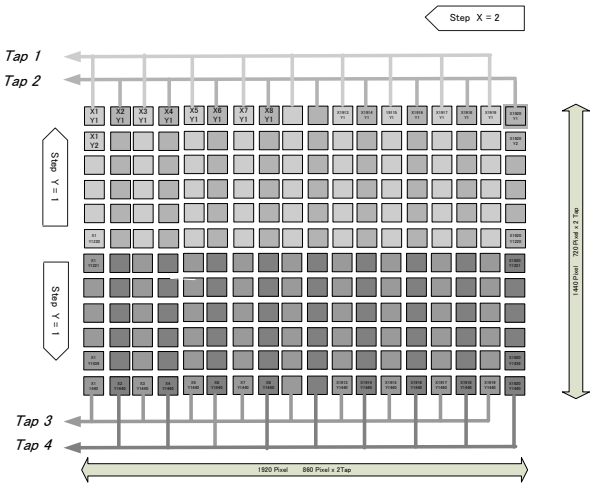


Fig.15 1X2-2YE readout

6.3 Output timing

6.3.1 Horizontal timing

6.3.1.1 Output format 1X2-2YE , 1X2-1Y

a) Vertical binning OFF

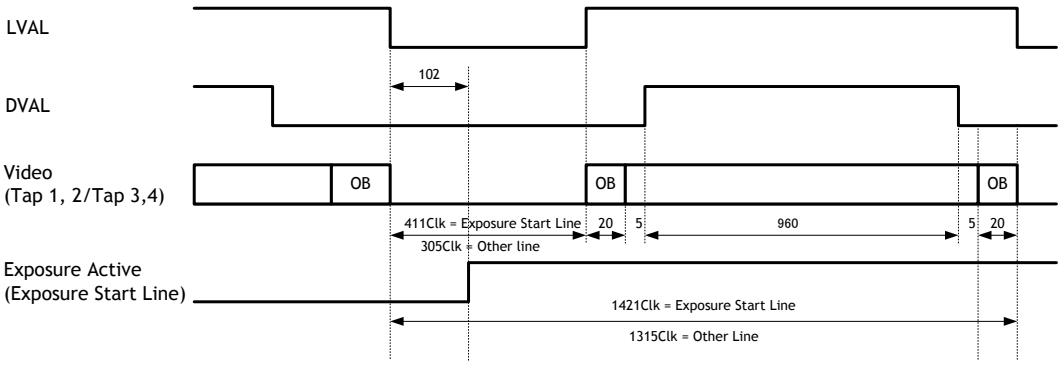


Fig.16 Horizontal Timing (Vertical timing OFF)

b) Vertical binning ON

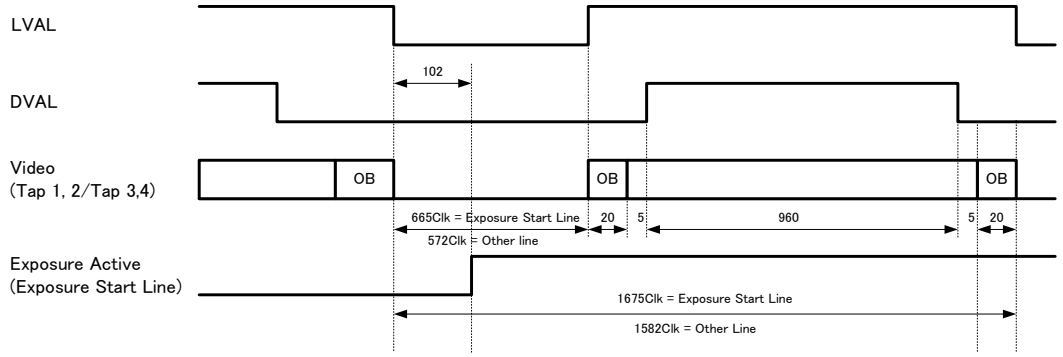


Fig. 17 Horizontal timing (Vertical binning ON)

6.3.1.2 Output format 1X-2YE , 1X-1Y

a) Vertical binning OFF

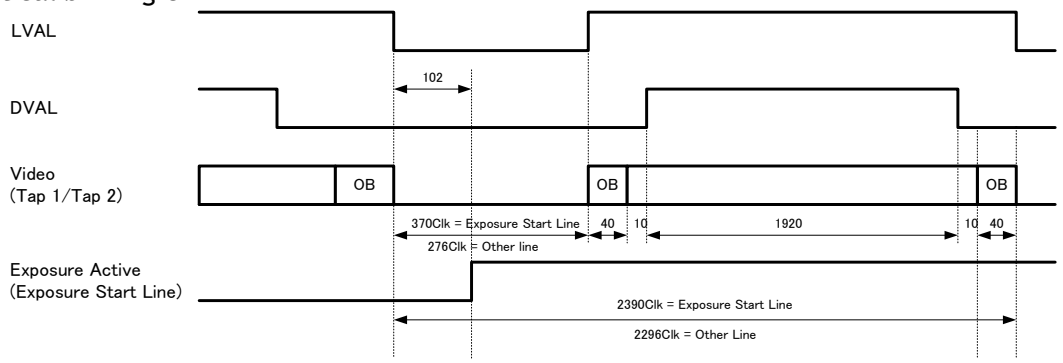


Fig.18 Horizontal timing (Vertical binning OFF)

b) Vertical binning ON

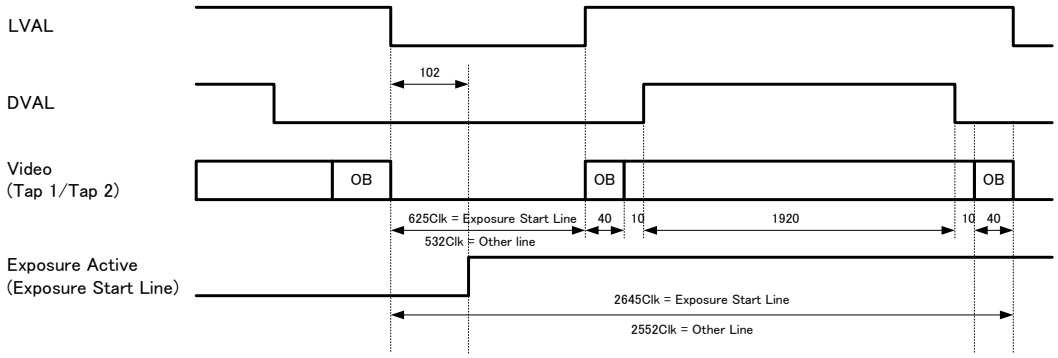


Fig.19 Horizontal timing (Vertical binning ON)

6.3.2 Vertical timing

6.3.2.1 Output format 1X2-2YE , 1X-2YE

a) Vertical binning OFF

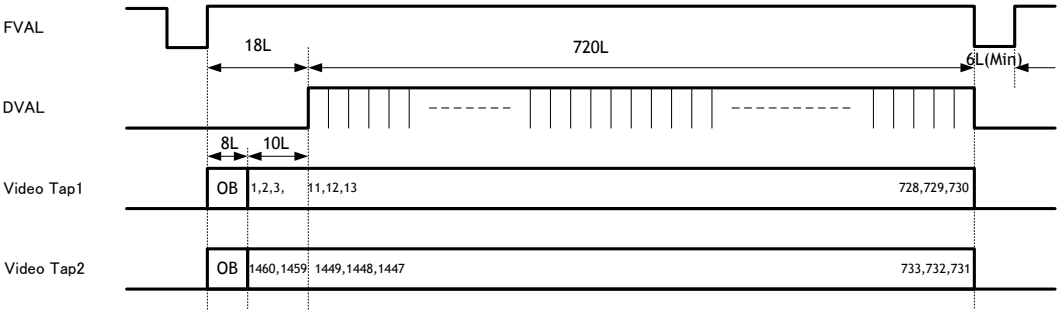


Fig.20 Vertical Timing (Vertical timing OFF)

b) Vertical binning ON

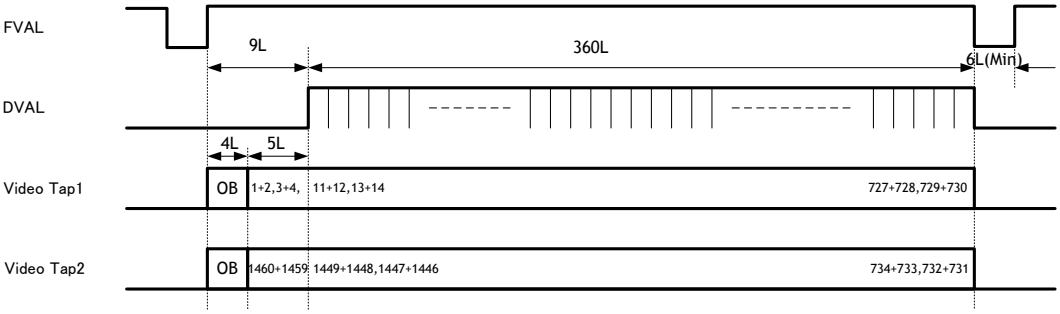


Fig. 21 Vertical timing (Vertical binning ON)

6.3.2.2 Output format 1X2-1Y , 1X-1Y

a) Vertical binning OFF

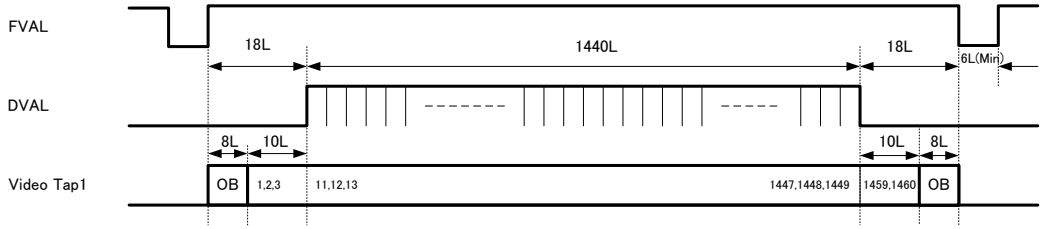


Fig.22 Vertical timing (Vertical binning OFF)

b) Vertical binning ON

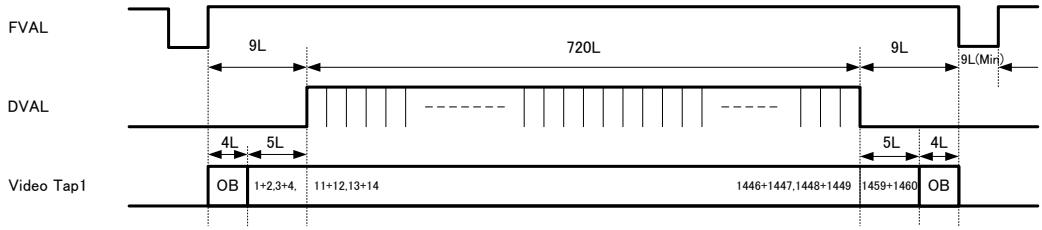


Fig.23 Vertical timing (Vertical binning ON)

6.3.3 ROI (Region Of Interest)

In the EL-2800M-PMCL and EL-2800C-PMCL, a subset of the image can be output by setting Height and Offset-Y in the Image Format Control section of the control tool. As the height is decreased, the number of lines read out is decreased and as the result, the frame rate is increased. The frame rate depends on the tap geometry and whether vertical binning is off or on. See section 7.1.2 for formulas that can be used to calculate the maximum frame rate for a specific ROI.

ROI can be set from 8 lines to 1440 lines in one-line increments for the EL-2800M-PMCL, or in two-line increments for the EL-2800C-PMCL.

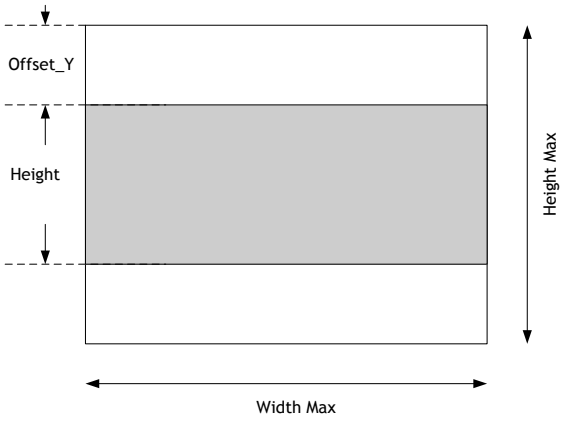


Fig. 24 ROI setting

6.4 Digital output bit allocation

Table – 16 Output level

CCD out			Analog Out (equivalent)	Digital Out		
				8bit	10bit	12bit
Black		0%	Setup 3.6%, 25mV	8LSB	32LSB	128LSB
Monochrome	574mV	100%	700mV	222LSB	890LSB	3560LSB
Color	386mV					
Monochrome	662mV	115%	808mV	255LSB	1023LSB	4095LSB
Color	445mV					

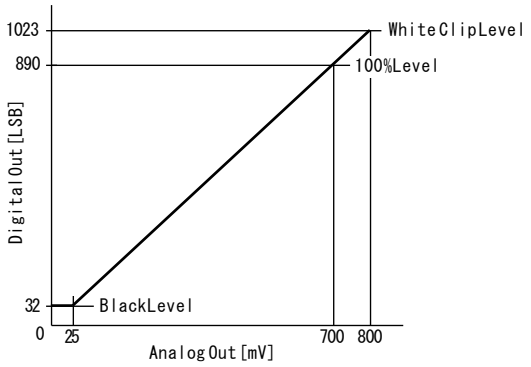


Fig.25 Bit allocation (10-bit)

7. Operating modes

The following controls are related to capturing the image.

7.1. Acquisition control (change the frame rate)

7.1.1 Acquisition frame rate

With Trigger OFF (free running mode – see section 7.2.1), the default frame rate of the camera is based on the specified ROI. The smaller the ROI, the faster the default frame rate. However, it is possible to specify a free-running frame rate (i.e., no trigger needed) that is slower than the default rate. This can be useful when a longer exposure time is needed for a specific ROI.

To change the frame rate, the user may modify the default value which is displayed in the AcquisitionFrameRate control based on the ROI specified. The user can type a number corresponding to the desired frame rate or move the slider control to the appropriate value. Allowed values range from the ROI's default fastest frame rate to a rate of 0.125 frames per second (8 seconds per frame). If the value entered is faster than the default frame rate, the setting is ignored and the default frame rate is used

The setting range in Acquisition Frame Rate is:

Fastest	to	Slowest
Maximum frame rate based on the area set by Image Format Control (ROI)	to	0.125 Hz = 8 seconds/frame

How to set:

ROI should be set first using Height and Offset Y settings in Image Format Control.
The number shown in Acquisition Frame Rate (RAW) will correspond to the fastest frame rate for the specified ROI.
The value can be adjusted as low as 0.125 fps (8 seconds per frame).
If ROI is changed from a smaller size to a larger size, the default frame rate of the ROI is automatically recalculated inside the camera and changed to the slower frame rate of the larger ROI.

7.1.2 Calculation of default frame rate

a) V Binning Off

1X2-2YE(fps) = 1/〔[Height/2 + {((720-(Height/2)-1)/4} + 25] × Line rate 〕
1X2-1Y(fps) = 1/【[Height + {(OffsetY-1)/4} + [{1440-(OffestY + Height)}/9] + 46 〕
× Line rate】
1X-2YE(fps) = 1/〔[Height/2 + {((720-(Height/2)-1)/4} + 25] × Line rate 〕
1X-1Y(fps) = 1/【[Height + {(OffsetY-1)/7} + [{1440-(OffestY + Height)}/15] + 46 〕
× Line rate】

b) V Binning On

1X2-2YE(fps) = 1/〔[(Height/4) + {((360-(Height/4)-1)/2} + 16] × Line rate 〕
1X2-1Y(fps) = 1/【[(Height/2)+ {(OffsetY-1)/2} + [{720-(OffsetY + (Height/2))}/4.5] + 28 〕
× Line rate】
1X-2YE(fps) = 1/〔[(Height/4)+ {((360-(Height/4)-1)/4} + 16] × Line rate 〕
1X-1Y(fps) = 1/【[(Height/2)+ {(OffsetY-1)/4} + [{720-(OffsetY + (Height/2))}/8] + 33 〕
× Line rate】

where,
Line rate
a) V Binning Off
1X2-2YE = 24.574us
1X2-1Y = 24.574us
1X-2YE = 42.519us
1X-1Y = 42.519us

b) V Binning On
1X2-2YE = 29.296us
1X2-1Y = 29.296us
1X-2YE = 47.259us
1X-1Y = 47.259us

7.2. Exposure control

7.2.1 Exposure Mode

Exposure Mode sets which exposure mode is to be used.
If the trigger is used, Frame Start must also be used.
When Exposure Mode is set to Timed or Trigger Width, the combination of Exposure Mode and Frame Start can set various operations.

The following table shows the operation depending on the combination.

Table – 17 Exposure mode

Exposure Mode	Trigger Control	Trigger OFF	Trigger ON
	Frame Start	Behavior	
OFF	OFF or ON	Self-running No exposure control	–
Timed (EPS) Timed(RCT) Timed (PIV)	OFF	Self-running Exposure control available	–
	ON	–	Operate in EPS, RCT or PIV
Trigger Width	OFF	Self-running No exposure control	–
	ON	–	Exposure control by trigger width

Frame Start trigger: Sets whether the start of the frame is controlled externally or not.
Trigger Mode ON: If Acquisition Active is active and Exposure Mode chooses Timed or Trigger Width, the exposure will be started by using the signal set in Frame Trigger as the trigger.
Trigger Mode OFF: If Acquisition Active is active, the camera operates in free-running mode.

Exposure Mode can be selected from the following.

OFF: No shutter control

Timed: The exposure will be set in advance. The setting can be done in μsec units.
Frame Start OFF: Free-running mode and exposure control is available.
Frame Start ON: EPS operation mode

In this status, if RCT or PIV is selected in Trigger option, the camera will operate in RCT or PIV mode.

Trigger Width : The exposure will be controlled by the width of the trigger pulse.
Frame Start OFF: Not active. No exposure control
Frame Start ON: PWC operation mode

7.2.2 Exposure Time

This command is effective only when Exposure Mode is set to Timed. It is for setting exposure time.
The setting step for exposure time is 1 μ sec per step.
Minimum: 10 μ sec
Maximum: 8 seconds

7.2.3 Exposure Auto

This is a function to control the exposure automatically. It is effective only for Timed.
ALC Reference controls the brightness.
There are three modes, OFF, Once and Continuous.
OFF: No exposure control
Once: Exposure adjusts when the function is set, then remains at that setting
Continuous: Exposure continues to be adjusted automatically

In this mode, the following settings are available.

ALC Speed: Rate of adjustment can be set (Common with Gain auto)
Exposure Auto Max: The maximum value for the exposure time to be controlled can be set
Exposure Auto Min: The minimum value for the exposure time to be controlled can be set
ALC Reference: The reference level of the exposure control can be set (Common with Gain auto)
ALC Channel area: The measurement area of the exposure control can be set

7.3. Trigger Mode

7.3.1 Trigger Source

The following signals can be used as the trigger source signal.
OFF
Line 4 (Input to TTL In 1 and output from Digital IO)
Line 7 (Input to CL CC1 In and output from Digital IO)

7.3.2 Trigger Activation

This command can select how to activate the trigger.
Rising Edge: At the rising edge of the pulse, the trigger is activated.
Falling Edge: At the falling edge of the pulse, the trigger is activated.

Level High: During the high level of trigger, the accumulation is activated
Level Low: During the low level of trigger, the accumulation is activated
If Exposure Mode is set to Trigger Width, Level High or Level Low must be used.

Table – 18 Trigger activation

	RisingEdge	FallingEdge	LevelHigh	LevelLow
Timed	○	○	×	×
TriggerWidth	×	×	○	○
Timed - PIV	○	○	×	×
Timed - RCT	○	○	×	×

7.3.3 Trigger Overlap

This function defines whether or not a trigger pulse can be accepted while data is being read out.
OFF: The trigger pulse is not accepted during CCD readout.
Read Out: The trigger pulse can be accepted during CCD readout.

7.3.4 Trigger Delay

This function is used to delay the trigger signal against the trigger input signal.
The step of the delay is 1μsec.
The setting range: 0 to 0.65,535 μsec (16-bit)

7.4. Normal continuous operation (Timed Exposure Mode/Trigger Mode OFF)

This is used for applications which do not require triggering. In this mode, the video signal

for the auto-iris lens is available.
For the video timing, refer to the chapter 6.3.
The frame rate of full pixels readout is 54.7 fps for 4-tap output.

Primary settings to use this mode

Trigger Mode: Off

Table – 19 Minimum interval of the image (1X2-2YE, 8-bit)

4 tap output	FULL	2/3 ROI	1/2 ROI	1/4 ROI	1/8 ROI	1/2V Binning
Minimum frame lines	774	564	474	339	272	375

Note: The read out area for each ROI is a centered readout (same number of lines for upper and lower)

7.5. Timed (EPS) mode

This mode allows a single image frame to be captured with a preset exposure time by using the external trigger. Additional settings determine if the trigger pulse can be accepted during the exposure period.
The frame rate of full pixels readout is 54.7 fps for 4-tap output.

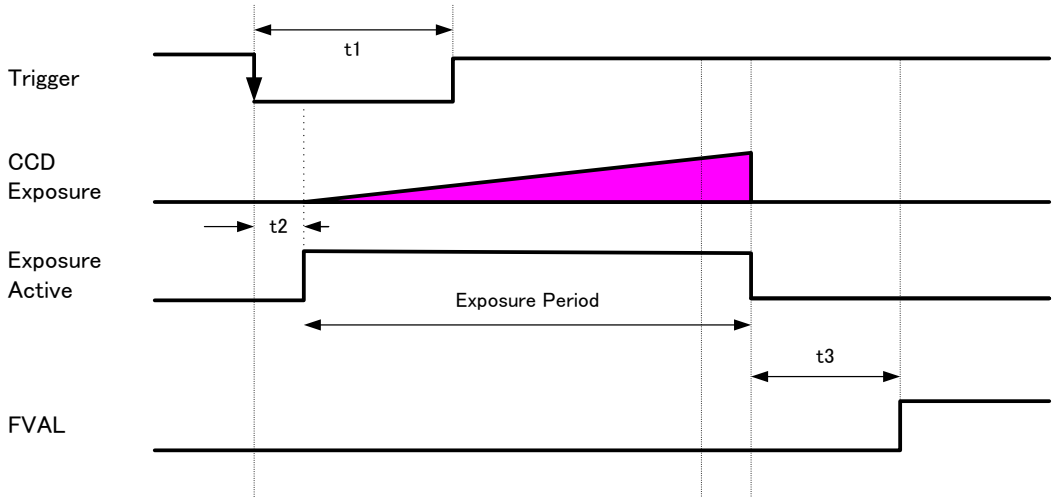
Primary settings to use this mode
Exposure mode: Timed
Trigger mode: ON

Table – 20 Minimum interval of the trigger pulse (1X2-2YE, 8-bit)

4 tap output	FULL	2/3 ROI	1/2 ROI	1/4 ROI	1/8 ROI	1/2V Binning
Minimum frame lines	745L	565L	475L	340L	273L	376L

Note: The read out area for each ROI is a centered readout (same number of lines for upper and lower)

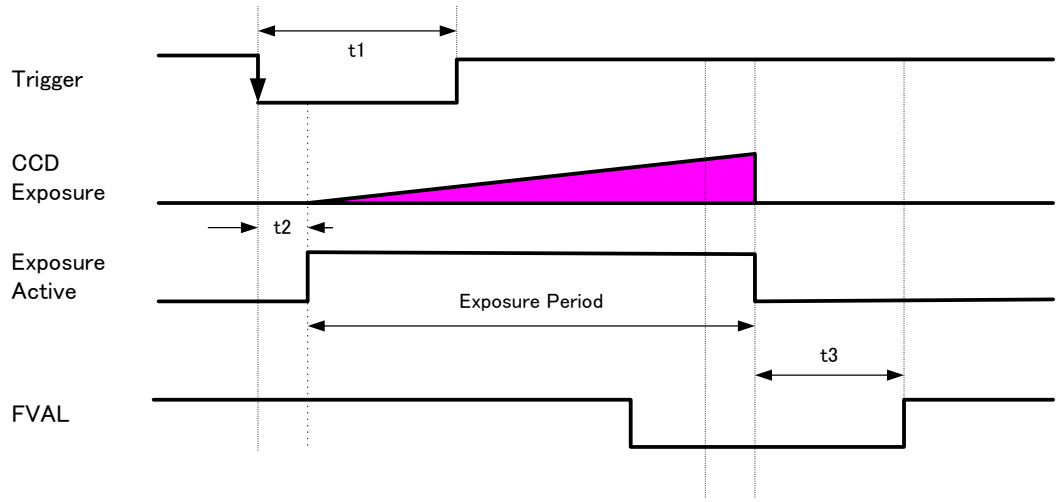
7.5.1 If the overlap setting is lse i



t1	t2	t3
8.1 μ sec (Typical)	2L (Min)	4.5 ～ 5.5L

Fig.26 Overlap OFF

7.5.2 If the overlap setting is lse is 54



t1	t2	t3
1L	2L (min)	4.5L ～5.5L

Fig.27 Readout

7.6. Trigger Width mode

In this mode, the exposure time is equal to the trigger pulse width. Accordingly, longer exposure times are supported. Additional settings determine if the trigger pulse can be accepted during the exposure period.

The frame rate of full pixels readout is 54.7 fps for 4-tap output.

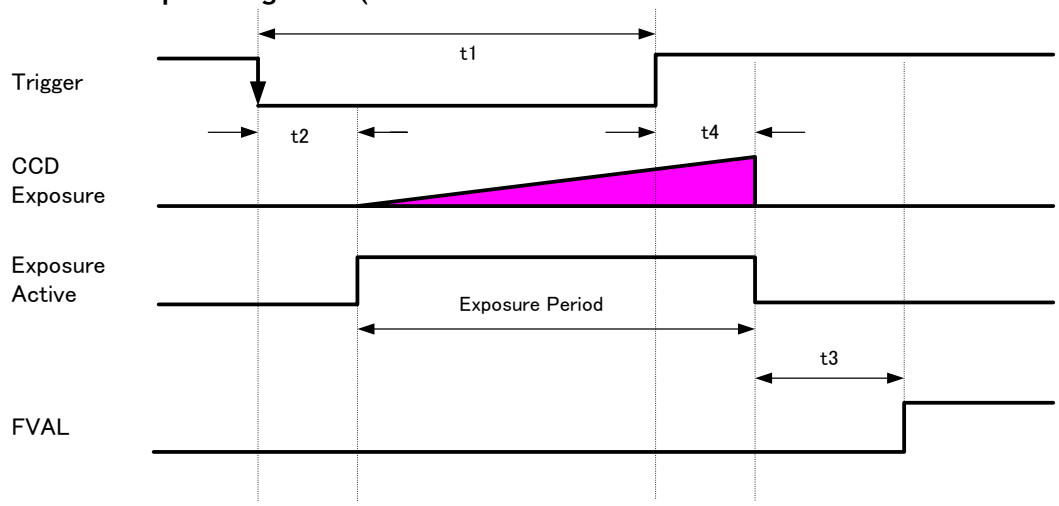
Primary settings to use this mode
Exposure mode: Trigger Width
Trigger mode: ON

Table – 21 Minimum interval of the trigger pulse (1X2-2YE, 8-bit)

4 tap output	FULL	2/3 ROI	1/2 ROI	1/4 ROI	1/8 ROI	1/2V Binning
Minimum frame lines	745	565	475	340	273	376

Note: The read out area for each ROI is a centered readout (same number of lines for upper and lower)

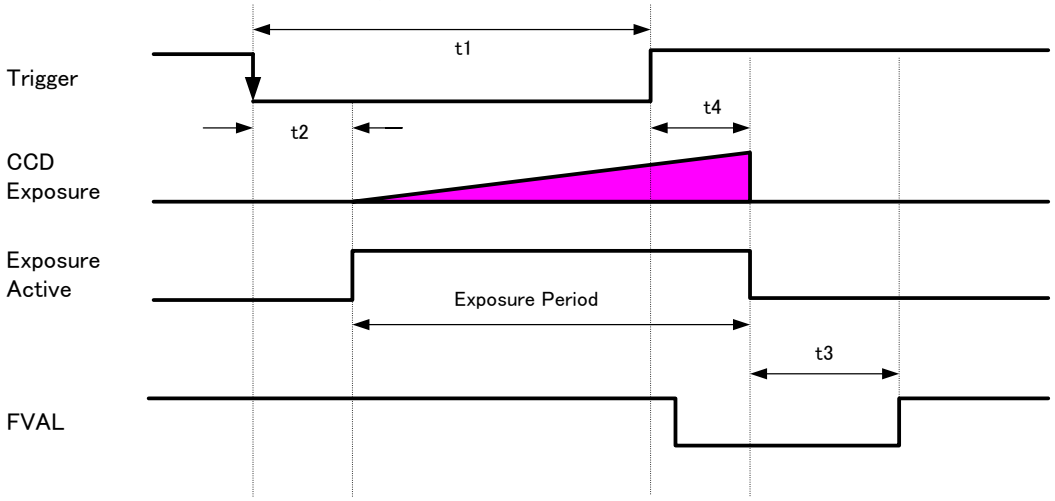
7.6.1 If the overlap setting is lse (



t1	t2	t3	t4
8.1 μ sec (Typical)	2L (min)	4.5L ～5.5L	8 μsec

Fig.28 Overlap = OFF

7.6.2 If the overlap setting is lse (1X24



t1	t2	t3	t4
1L	2L (min)	4L	1L + 8 μsec

Fig.29 Readout

7.7. RCT mode

Until the trigger is input, the camera operates continuously and the video signal for the auto-iris lens is output. During this time, the video signal, FVAL and LVAL are output but DVAL is not output. When the trigger is input, the fast dump is activated to read out the electronic charge very quickly, after which the accumulation and the readout are performed. When the accumulated signal against the trigger is read out, FVAL, LVAL and DVAL are output too.

Primary settings to use this mode

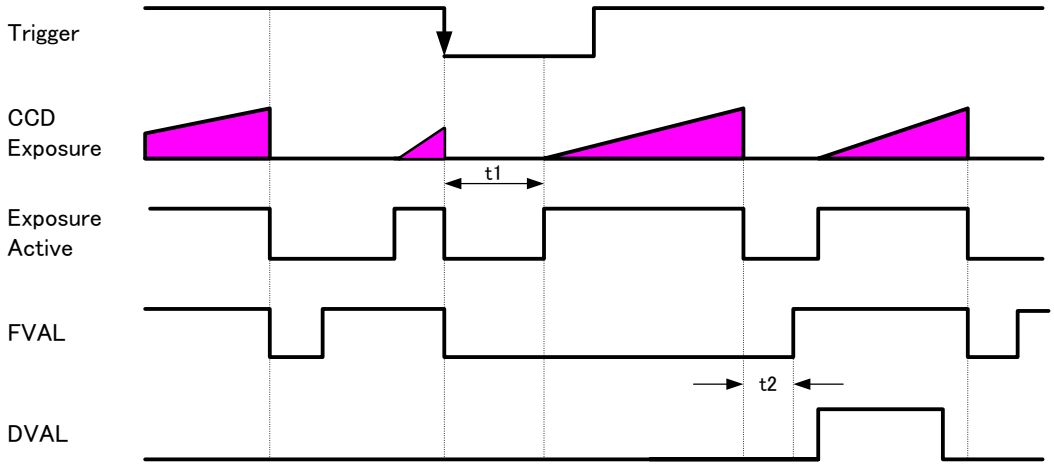
Exposure mode: Timed
Trigger mode: ON
Trigger option: RCT

In this mode, the setting of Trigger Overlap is invalid.

Table – 22 Minimum interval of the trigger pulse (1X2-2YE, 8-bit, Exposure time = 10μs)

4-tap output	FULL	2/3 ROI	1/2 ROI	1/4 ROI	1/8 ROI	1/2V Binning
Minimum frame lines	Timed Exposure Mode/Trigger Mode OFF + Exposure Time + 195					

Note: The read out area for each ROI is a centered readout (same number of lines for upper and lower)



Output format	t1	t2
1x2-2YE, 1X-2YE	194L	4.5L ～5.5L
1X2-1Y, 1X－1Y	384L	4.5L ～5.5L

Fig.30 RCT mode timing

7.8. PIV (Particle Image Velocimetry)

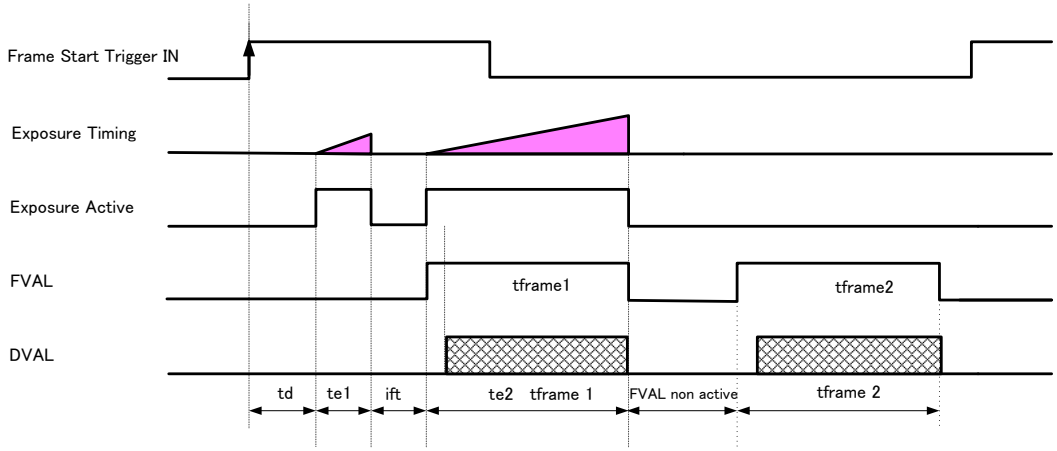
The Particle Image Velocimetry mode can be used in applications where 2 images need to be taken with a very short time interval. It can only be used with strobe flash as illumination. The first accumulation time is 10 μsec to 2 sec. Then, the second exposure will be taken. The accumulation is LVAL asynchronous. The first strobe is activated during the first exposure duration and the second strobe is pulsed while the first frame is being read out. In this way, two strobe flashes generate two video outputs.

Primary Settings
Exposure Mode: Timed
Trigger Mode: ON
Trigger Option: PIV

In this mode, the setting of Trigger Overlap is invalid.

Table - 23 Minimum trigger interval (1X2-2YE, 8-bit)

4-tap output	FULL	2/3 ROI	1/2 ROI	1/4 ROI	1/8 ROI	1/2V Binning
Minimum frame lines	(Timed Exposure Mode/Trigger Mode OFF) x 2 + Exposure Time + 1					



time name	description	time
td	Exposure beginning delay	8.1 µsec (Typical)
te1	First exposure time period	10 µs ～ 2 s
te2	Second exposure time	1 frame
itf	Inter framing time	3.4 µsec
	FVAL non active	4LVAL
tframe1	First Frame read out	1 frame
tframe2	Second Frame read out	1 frame

Fig.31 PIV mode

7.9. Sequential Trigger

7.9.1 Video send mode

The sequential trigger mode has the following modes and it is selected in the video send mode.

Table – 24 Video send mode

Video send mode	How to select the index
Trigger Sequence	Select the index by the frame start trigger signal. (The setting index can be determined by the next index setting.)
Command Sequence	Select the index number to assign directly by the command sequence index command.

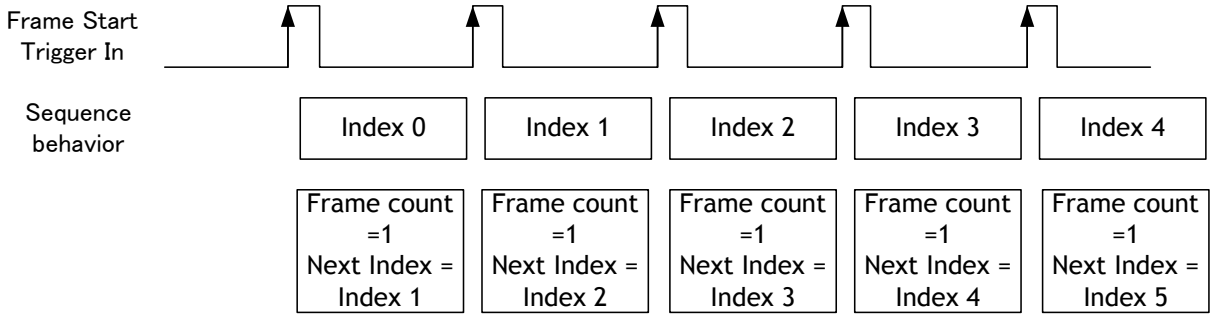


Fig. 32 Behavior of Sequence trigger

Table - 25 Minimum trigger interval (1X2 – 2YE, 8-bit, Exposure time=10 μs)

4-tap output	FULL	2/3 ROI	1/2 ROI	1/4 ROI	1/8 ROI	1/2V Binning
Minimum frame line	Timed Exposure Mode/Trigger Mode OFF + Exposure Time + 1					

Note 1. Overlap mode=Readout is not available
Note 2. The minimum interval calculation assumes that the exposure times for all sequences are equal. If there are differences, it is necessary to add the differences to the calculation. If the exposure times are different, it is recommended to organize the exposure times from the shortest exposure to the longest one.
Note 3. The sequence must start with Index 0. After Index 0 is executed, the sequence proceeds to the next setting index.

Table – 26 Sequence Index table (Default)

Sequence ROI Index	Sequence ROI													
	Width	Height	Offset		Gain Selector			Exposure Time	Black Level	Binning		LUT Enable	Frame Count	Next Index
			X	Y	Gain (ALL)	Red	Blue			Horizontal	Vertical			
- Index 0		1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 1		1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 2		1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 3		1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 4		1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 5		1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 6		1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 7		1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 8		1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 9		1440	0	0	0	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0

7.9.2 Sequence ROI setting parameters

Setting parameters for Sequence ROI is as follows.

(1) Sequence ROI Index Selector
In Sequence ROI Index Selector, Index 0 to 9 can be selected.
Sequence ROI – Width, Height, Offset X, Offset Y, Gain Selector - Gain/Red/Blue, Exposure Time, Black Level, Binning Horizontal, Binning Vertical, LUT Enable, Frame Count, Next Index for the selected index are displayed.

(2) Sequence ROI Width
Width is fixed at 1920. No setting is necessary for this parameter.

(3) Sequence ROI Height
Set the height of sequence ROI. The setting range is 8 to 1440 lines.
Rules for setting area and step number are the same as the normal ROI mode set by [Video Send Mode] = “Normal”.

(4) Sequence ROI Offset X
This parameter is fixed at 0.

(5) Sequence ROI Offset Y
Set Offset Y of sequence ROI.
Sequence ROI Binning Vertical =1 (Off):
Setting range is 0 to (1432 - [Sequence ROI Height])
Sequence ROI Binning Vertical =2 (On):
Setting range is 0 to (712 - [Sequence ROI Height])
The limitations of step number and other factors are the same as the normal ROI mode set by [Video Send Mode] = "Normal".
In 1X2-2YE and 1X-2YE, as only Height is set at the center of upper and lower taps, OFFSET Y setting is not enabled.

(6) Sequence ROI Gain Selector
In Sequence ROI Gain Selector, the gain settings for each index are available.
EL-2800C-PMCL: Gain(ALL), Red and Blue can be set.
EL-2800M-PMCL: Only Gain is displayed and can be set.

(7) Sequence ROI Black Level
Black Level setting is available for each index.

(8) Sequence ROI Exposure Time
Exposure Time setting is available for each index.

(9) Sequence ROI Binning Horizontal
ON or OFF of Horizontal Binning for each index can be set.

(10) Sequence ROI Binning Vertical
ON or OFF of Vertical Binning for each index can be set.

(11) Sequence ROI LUT Enable
Enable or disable of LUT function for each index 0 to 9 can be set.

(12) Sequence ROI Frame Count
This can set how many times the selected index is repeated. This is applied to each index. Triggers are input according to numbers set in Frame Count and index is repeated and moves to the next index. Therefore, the same number of triggers as Frame Count must be input.

(13) Sequence ROI Next Index
The number of the index that will follow the current index can be set.
If [Video Send Mode] is set to "Trigger Sequence" and the trigger pulse is input in EPS trigger, the sequence is executed from index 0.
Accordingly, after the number of frame count of index 0 is set, next index setting of index0 will be the first separation of sequence.

(14) Sequence ROI Reset Command
This command resets the current index pointer and reverts to index 0 in the table. Frame Count is also re-initialized.

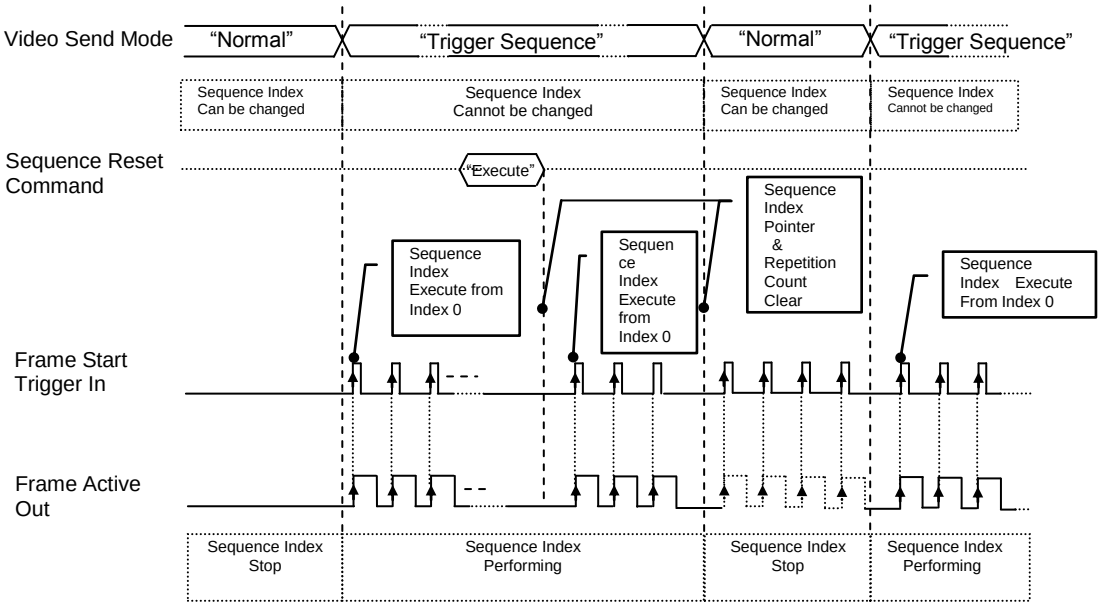


Fig. 33 Sequence trigger timing

7.10. Operation and function matrix

Table – 27 Operation and function matrix

Exposure operation	Trigger mode	Trigger option	V. Binning (Note1)	H. Binning (Note1)	Exposure	ROI (Partial scan)	Auto White Balance (Note2)	Auto Tap Balance	Auto Iris Output	Auto gain	Auto Exposure	Over Lap
OFF	OFF	OFF	1	1	×	○	○	○	○	○	×	×
			2	2	×	○	○	○	○	○	×	×
Timed	OFF	OFF	1	1	○	○	×	×	○	○	○	×
			2	2	○	○	×	×	○	○	○	×
Timed	ON	OFF	1	1	○	○	×	×	×	×	×	○
			2	2	○	○	×	×	×	×	×	○
Trigger Width	ON	OFF	1	1	×	○	×	×	×	×	×	○
			2	2	×	○	×	×	×	×	×	○
RCT	ON	RCT	1	1	○	○	○	○	○	○	○	×
			2	2	×	×	○	○	×	×	×	×
PIV	ON	PIV	1	1	×	○	×	×	×	×	×	×
			2	2	×	×	×	×	×	×	×	×
Sequence trigger	ON	Sequence trigger	1	1	○	○	×	×	×	×	×	×
			2	2	○	○	×	×	×	×	×	×

Note 1. Only EL-2800M
Note 2: Only EL-2800C

8. Other functions

8.1 Black level control

This function adjusts the setup level.
Variable range: -256 to 255 LSB (at 10-bit output)

8.1.1 Black Level Selector

The following factors can be set.

EL-2800M: DigitalAll/Tap1All/Tap2All/Tap3All/Tap4All
EL-2800C: DigitalAll/Tap1All/Tap1Red/Tap1Blue
Tap2All/Tap2Red/Tap2Blue
Tap3All/Tap3Red/Tap3Blue
Tap4All/Tap4Red/Tap4Blue

8.1.2 Black Level

The black level can be set in the following range.

EL-2800M: DigitalAll : -256～255
Tap1All : -512～ +511
Tap2All:-512～ +511
Tap3All:-512～ +511
Tap4All:-512～ +511

EL-2800C: DigitalAll:-256～255
DigitalRed All/DigitalBlue:-512～ +511
Tap1All/Tap1Red/Tap1Blue:-512～ +511
Tap2All/Tap2Red/Tap2Blue:-512～ +511
Tap3All/Tap3Red/Tap3Blue:-512～ +511
Tap4All/Tap4Red/Tap4Blue:-512～ +511

8.1.3 Black Level Auto

The tap balance of black level can be adjusted.
This requires closing the lens iris or capping the lens in order to cut the incident light.
OFF: Adjust manually
Once: Adjust only one time when this command is set.

The detection area can be selected by BalanceWhiteChannelArea. The detection area is selected individually from the following areas or the entire screen.

High Left	High Mid-left	High Mid-right	High Right
Mid-High Left	Mid-High Mid-left	Mid-High Mid-right	Mid-High Right
Mid-Low Left	Mid-Low Mid-left	Mid-Low Mid-right	Mid-Low Right
Low Left	Low Mid-left	Low Mid-right	Low Right

Fig.34 Detection area

8.2 Gain control

The EL-2800M-PMCL can adjust the gain level from 0dB to +30dB using 0dB as the reference (Factory default). In the EL-2800C-PMCL, the master gain can be adjusted from 0dB to +27dB and R and B gains can be adjusted in the range of -7dB to + 12.99dB using the master gain as the reference.
Resolution:
Master Gain: 0.035dB/Step
Blue/Red Gain: x0.00012 /Step

The master gain uses an analog gain and digital gain internally. All digital gain has the resolution of x0.00012/Step and provides more precise gain setting.

The magnification of digital gain is calculated in the following formula.

$$\text{Digital GainMagnification} = \frac{\text{Gain Value} + 8192}{8192}$$

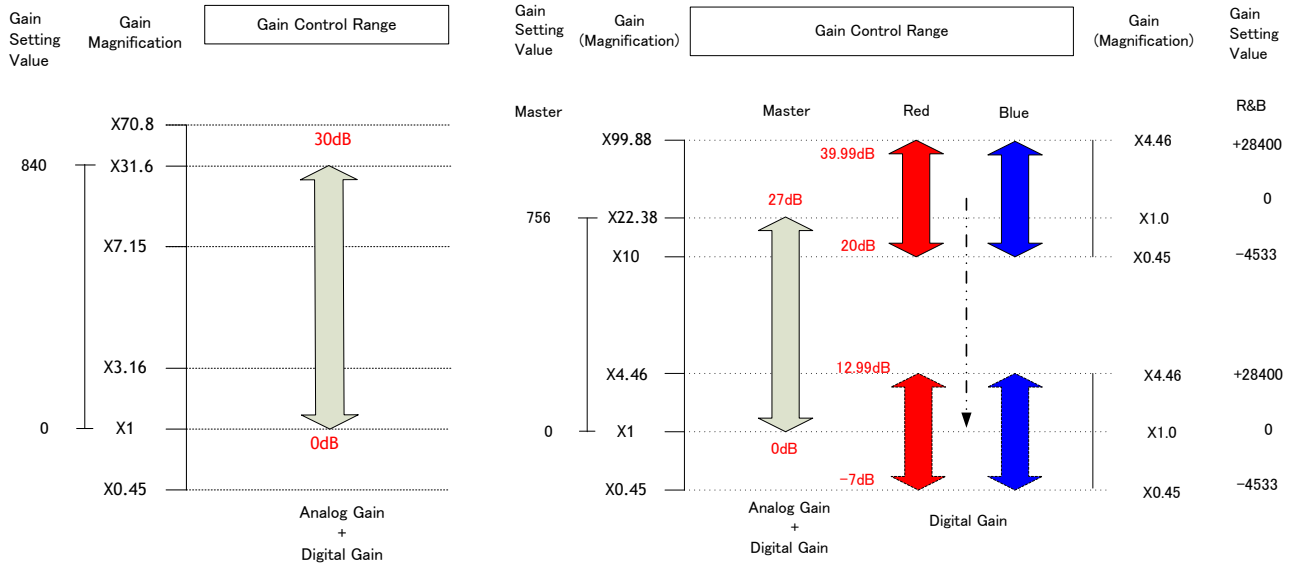


Fig. 35 Gain control

8.2.1 Gain Selector

The following parameters can be set.
EL-2800M: AnalogAll/DigitalAll/Digital Tap2/Digital Tap3/Digital Tap4
EL-2800C: AnalogAll/DigitalAll/Digital Red All/Digital Blue All
/DigitalTap2All/DigitalTap3All/DigitalTap4All
/DigitalTap2Red/DigitalTap2Blue
/DigitalTap3Red/DigitalTap3Blue
/DigitalTap4Red/DigitalTap4Blue

8.2.2 Gain

This is reference vale to advise the magnification. The operational adjustment is done in Gain RAW.
EL-2800M: AnalogAll：0.7079～32.1
DigitalAll：0.7079～1.4125
Digital Tap2All：0.8912～1.1220
Digital Tap3All：0.8912～1.1220
Digital Tap4All：0.8912～1.1220

EL-2800C: AnalogAll：1.0～22.7
DigitalAll：0.7079～1.4125
Digital Red All：0.4466～4.4688
Digital Blue All：0.4466～4.4688
Digital Tap2All：0.8912～1.1220
Digital Tap2Red：0.8912～1.1220
Digital Tap2Blue：0.8912～1.1220
Digital Tap3All：0.8912～1.1220
Digital Tap3Red：0.8912～1.1220
Digital Tap3Blue：0.8912～1.1220
Digital Tap4All：0.8912～1.1220
Digital Tap4Red：0.8912～1.1220
Digital Tap4Blue：0.8912～1.1220

8.2.3 Gain Raw

The gain raw can be adjusted in the following range.
EL-2800M: AnalogAll：0 ～ 840
DigitalAll：-2393～+3379/
Digital Tap2All/ Digital Tap3All/ Digital Tap4All：-891～+1000
EL-2800C: AnalogAll：0 ～ 756
DigitalAll：-2393～+3379/
Digital Tap2All/Digital Tap3All/Digital Tap4All：-891～+1000/
Digital Red All/Digital Blue All：-4533～28400
Digital Tap2Red/Digital Tap2Blue：-891～+1000
Digital Tap3Red/Digital Tap3Blue：-891～+1000
Digital Tap4Red/Digital Tap4Blue：-891～+1000

8.2.4 Gain Auto

This function automatically controls the gain level. This function is effective only for Frame trigger OFF and RCT modes. This is controlled by the command JAI AGC Reference.
There are three modes.

OFF:	Adjust manually.
Once:	Operate only one time when this command is set
Continuous:	Operate the auto gain continuously

The following detailed settings are also available.

ALC Speed:	The rate of adjustment of GainAuto can be set.(Common with Exposure Auto)
Gain Auto Max:	The maximum value of GainAuto control range can be set
Gain Auto Min:	The minimum value of GainAuto control range can be set
ALC Reference:	The reference level of Gain Auto control can be set (Common use with Expsoure Auto)
ALC channel area:	The area of GainAuto control can be set, either entire area or individual section

High Left	High Mid-left	High Mid-right	High Right
Mid-High Left	Mid-High Mid-left	Mid-High Mid-right	Mid-High Right
Mid-Low Left	Mid-Low Mid-left	Mid-Low Mid-right	Mid-Low Right
Low Left	Low Mid-left	Low Mid-right	Low Right

Fig. 36 ALC channel area

8.2.5 Balance White Auto

This is auto white balance control function.
The operation can be selected from the followings.

OFF: Adjust manually.
Once: Operate only one time when this command is set
Continuous: Operate the white balance control continuously

AWB channel area is the same as the gain and black controls.

8.3. LUT

This function can be used to convert the input to the desired output characteristics.
The Look-Up Table (LUT) has 256 points for setup. The output level can be created by multiplying the gain data by the input level. In the EL-2800C-PMCL, the same LUT characteristic is applied independent of the color value

8.3.1 LUT Enable

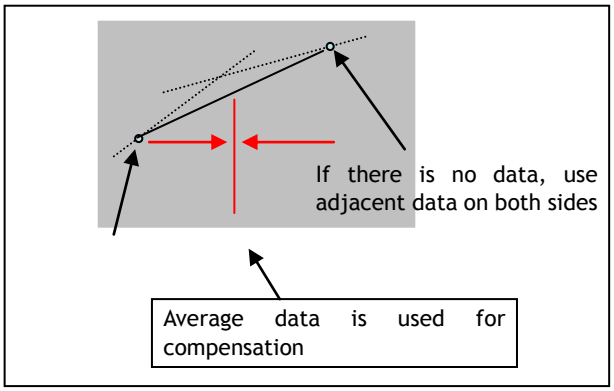
ON or OFF LUT function.

8.3.2 LUT Index

The number of LUT data elements is 256. The lowest level is Index 0 and the highest level is Index 255.

8.3.3 LUT value

There are 256 LUT data elements to which a value can be assigned. The minimum LUT value is 0 and the maximum LUT value is 255.
The data between each LUT data element is calculated from adjacent data elements.
In the color camera, LUT characteristics for R, G and B are the same.



Output Data = Video IN x LUT data
Fig. 37 LUT value

8.4. Gamma

This command is used set gamma between gamma 0.45 and gamma 1.0 (OFF).
The gamma value is an approximate value.

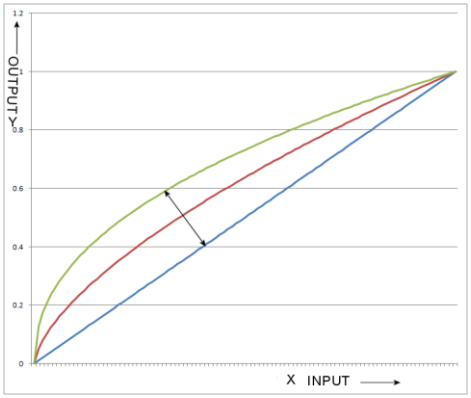


Fig. 38 Gamma compensation

8.5. Shading Correction

This function compensates for shading (non-uniformity) caused by the lens or the light source used. This compensation can be performed even if shading issues are not symmetrical in horizontal and/or vertical directions.

There are two methods of correction.

Flat shading correction:
The method to compensate the shading is to measure the highest luminance level in the image and use that data as the reference. Luminance levels of other areas are then adjusted so that the level of the entire area is equal. The block for compensation is 24 pixels (H) x 18 pixels (V) and the complementary process is applied to produce the compensation data with less error.

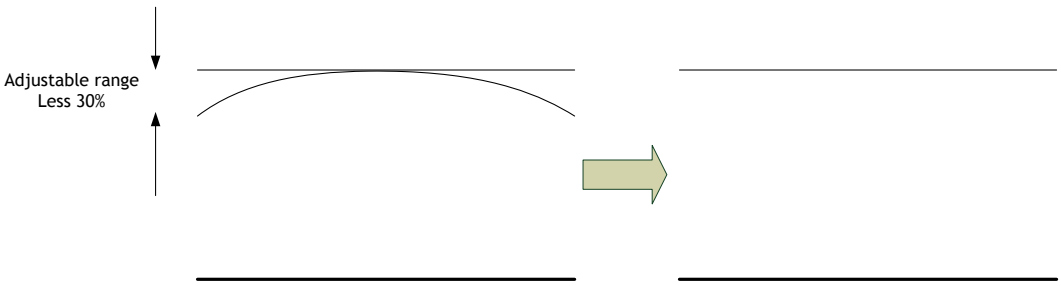


Fig. 39 Flat shading correction concept drawing

Color shading correction (For EL-2800C only):
In this case, R channel and B channel are adjusted to match with G channel characteristics. The block for compensation is 24 pixels (H) x 18 pixels (V) and the complementary process is applied to produce the compensation data with less error.

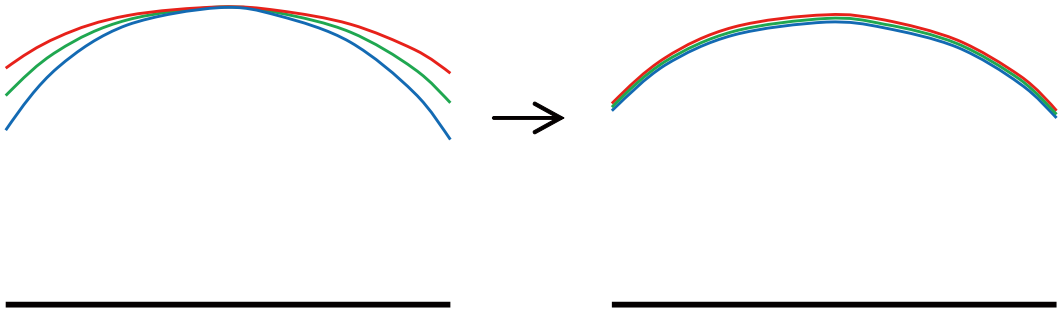


Fig.40 Color shading correction concept drawing

Note: Under the following conditions, the shading correction circuit may not work properly.
1. If there is some area in the image with a video level less than 70%
2. If part of the image or the entire image is saturated
3. If the highest video level in the image is less than 300LSB (at 10-bit output)

8.6. Blemish compensation

The EL-2800M-PMCL and EL-2800C-PMCL have a blemish compensation circuit. This function compensates blemishes on the CCD sensor (typically pixels with extremely high response or extremely low response). This applies to both monochrome and color versions. Pixels that fulfill the blemish criteria can be compensated by adjacent pixels in both columns and, in the case of the EL-2800C-PMCL, the defective pixels can be compensated by the same Bayer color pixels in both adjacent columns. The number of pixels that can be compensated is up to 64 pixels per tap, for a total of 256 pixels.

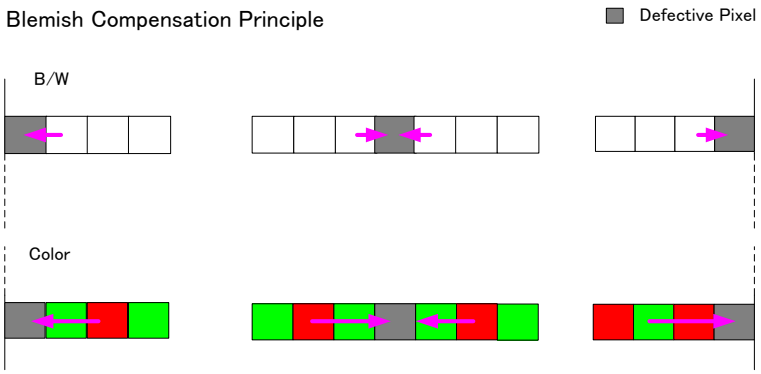


Fig. 41 Blemish compensation

Note: If defective pixels are found consecutively in the horizontal direction, the blemish compensation circuit does not work.

8.7. Bayer color interpolation (Only for EL-2800C)

This function is available only for EL-2800C-PMCL. The EL-2800C-PMCL uses a CCD with an RGB Bayer pattern. If the in-camera Bayer color interpolation is not used, the following RAW data can be output.

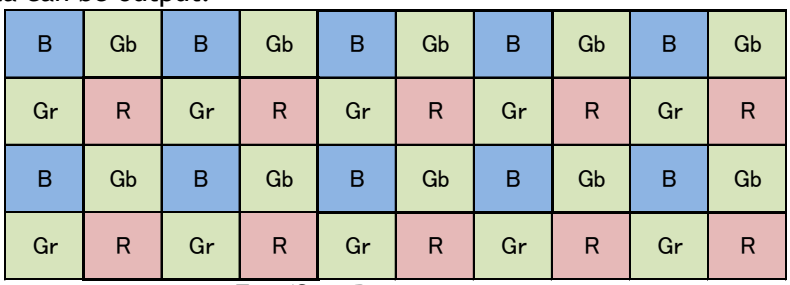


Fig.42 Bayer pattern

The RAW data contains only luminance information for each color and outputs as a monochrome signal. The Bayer color interpolation function can complement lacking color information on each pixel and output RGB color data as the result. Color interpolation compensates for the lack of color information by using information from adjacent pixels. The following is the concept drawing for the color interpolation process.

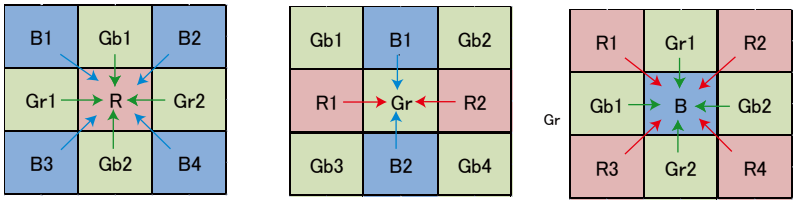


Fig.43 Color interpolation concept drawing

8.8 Lens

The EL-2800M-PMCL and EL-2800C-PMCL can be used with 4 different types of auto iris lenses, in addition to standard lenses with manual iris control. If an auto iris function is to be utilized, the lens type used must be selected in Lens Select.

Table -28 Lens selector

Lens Select	Description (Control with camera)	Note
P-Iris Lens	1) Iris position can be remotely controlled manually 2) Auto iris control is also available	If P-iris lens is used, the specific model name should be selected in lens select.
Motor controlled lens	1) Iris position can be remotely controlled manually 2) Auto iris control is also available	
Video iris lens	Only auto iris control is available	Factory Option (Use AUX option 1)
DC iris lens	Only auto iris control is available	Factory Option (Use AUX option 1)

8.8.1 About P-Iris

New Elite Series EL-2800M-PMCL and EL-2800C-PMCL come equipped with P-Iris control as part of the standard lens control function. The P-Iris system is a newly developed lens control method designed to control the iris more precisely. Especially for video cameras in surveillance applications utilizing megapixel CCD or CMOS imagers, it becomes a very important factor to control an iris in order to achieve the maximum camera performance. In surveillance applications, depending on shooting conditions, resolution and depth of field are important factors. The iris is deeply related with these factors. If the iris diaphragm is smaller, but not too small, resolution gets better and the depth of field is also deeper. The P-Iris system controls the iris diaphragm precisely and maintains the best image with the highest resolution and depth of field. P-Iris can also combine with gain and electronic shutter to keep the appropriate iris position under changing lighting conditions (ALC function).

8.8.2 Setting for P-iris lens being used

P-iris lenses use an absolute setting value control system and therefore, if the following parameters are input, precise iris position control is possible.

8.8.2.1 P-Iris lens select

Select the lens used. At present time, the following two lenses are available for these cameras.

P-Iris lens select	Description	Control step number	Open F value
LM16JC5MM	KOWA 16mm 2/3-inch	74	F1.4
LM35JC5MM	KOWA 35mm 2/3-inch	73	F2.0

8.8.2.2 Step max.

Iris control step depends on lens. The setting value uses the value stored in the camera. Refer to the table above for the control step number.

8.8.2.3 Position

The iris position can be set between 0 to Step Max. 0 means to open the iris and Step Max means to close the iris. The camera initializes P-iris control and acquires iris position under the following conditions:

1) When the camera is powered
2) When the lens is selected in P-Iris lens select
3) If the lens is changed in P-iris lens select

8.8.2.4 Current F value

The current F value is indicated by using iris position information. This can be indicated during auto iris operation. The relation between iris position and F value depends on the lens used.

8.8.2.5 P-Iris Auto min. / P-Iris Auto max.

This function can set the control range when the iris is operated automatically. Auto max. sets the limit when the iris goes open and Auto min. sets the limit when the iris goes closed. Auto max. can be set to fully open but Auto min. is stopped at F5.6 as lens performance typically degrades if the iris is closed beyond this point.

8.8.2.6 Auto Iris Lens Control Signal Output

If the auto iris lens is used, this parameter should be ON. This is common for all types of auto iris lens.

8.8.3 Motorized lenses

The EL-2800C-PMCL and EL-2800C-PMCL can use the 3-axis motorized lens control for zoom, focus and iris. The following functions are available via the motorized lens commands.

8.8.3.1 Iris

Open: While this command is supplied, the iris will continue to open.
Close: While this command is supplied, the iris will continue to close.
Stop: When this command is supplied, the iris operation stops.

8.8.3.2 Zoom

Wide: While this command is supplied, the zoom will continue to move towards wide angle.
Tele: While this command is supplied, the zoom will continue to mode towards telephoto.
Stop: When this command is supplied, the zoom operation stops.

8.8.3.3 Focus+

Near: While this command is supplied, the focus will continue to shift closer to the camera.
Far: While this command is supplied, the focus will continue to move towards infinity.
Stop: When this command is supplied, the focus operation stops.

8.8.4 Exclusive video output signal for iris control

This signal can be used for automatic lens iris control in Continuous and RCT modes.
The iris video signal is composed to average the video level in the center area of each frame and can be output as a composite signal with H-sync. This signal is always output from the No. 4-pin of the Hirose 12P connector and can also be output from the Hirose 10P AUX connector as a factory option.

The following drawing shows the waveform of the iris control video signal. This signal is output with the same video level within the same frame and the average is recalculated with each new frame.

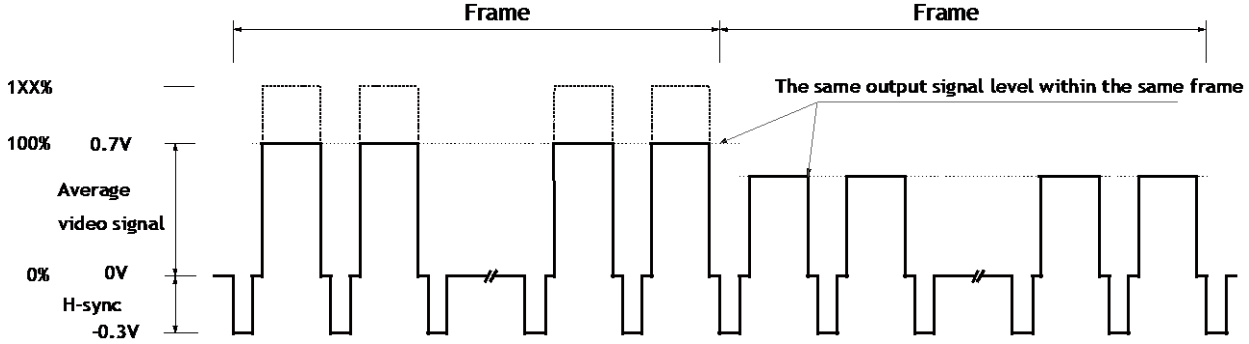


Fig. 44 Iris video output signal

The following parameters of this auto iris control signal output can be changed.

Auto Iris Control Signal Output:
ON: The auto iris control can be connected with AGC and ASC as ALC function
OFF: The auto iris control is not connected with AGC and ASC.

Iris State Control:
Video: Use the iris control in auto mode.
Close: Force the iris to close.
Open: Force the iris to open.

8.9 ALC

In the EL-2800M-PMCL and EL-2800C-PMCL, auto gain, auto shutter and auto iris functions can be combined to provide a wide ranging automatic exposure control from dark to bright or vice versa. The functions are applied in the sequence shown below and if one function is disabled, the linkage between the other two is maintained.

In order to make the ALC function effective, set the Auto Iris Lens Control Signal Output to "ON". The auto iris function works together with AGC and Exposure Auto.

If the lighting condition is changed from bright to dark AIC — ASC — AGC
If the lighting condition is changed from dark to bright AGC — ASC — AIC

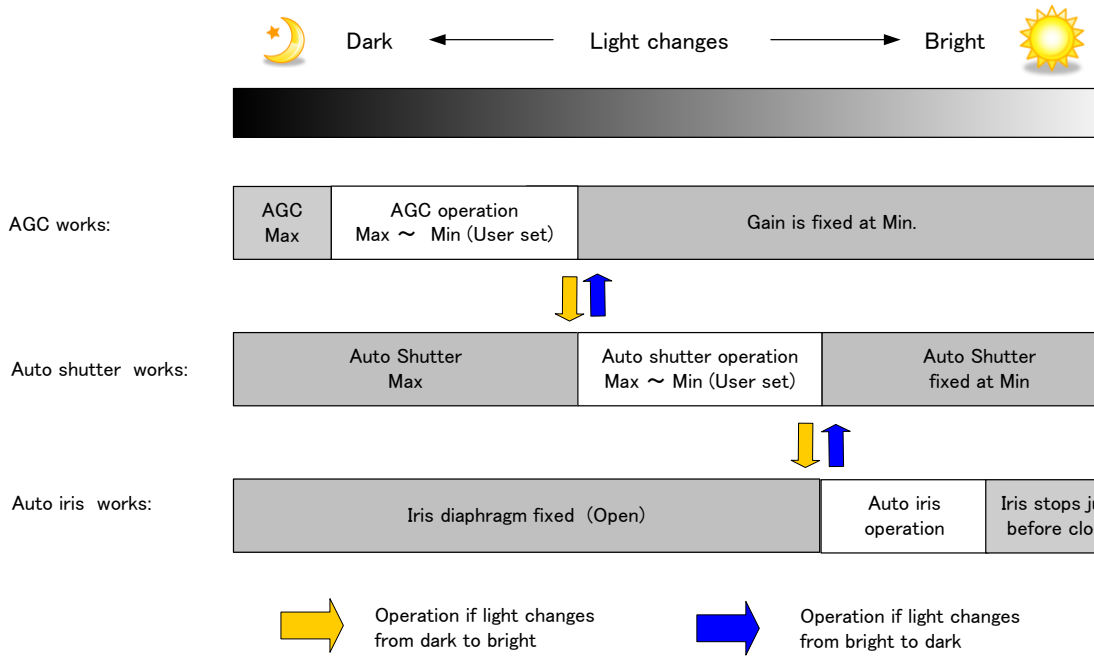


Fig.45 ALC function concept

ALC Reference will determine the target video level for AGC, Auto Shutter and/or Auto iris. For instance, if ALC Reference is set to 100% video level, AGC, Auto Shutter and/or Auto iris will function to maintain 100% video level.

■ Please note that ALC function is available only in continuous mode, as well as RCT mode.

9. Camera Control Tool

In the EL-2800M-PMCL and EL-2800C-PMCL, control of all camera functions can be done by the JAI SDK and Control Tool software. All controllable camera functions are stored in an XML file inside of the camera. The JAI SDK and Control Tool software can be downloaded from www.jai.com.

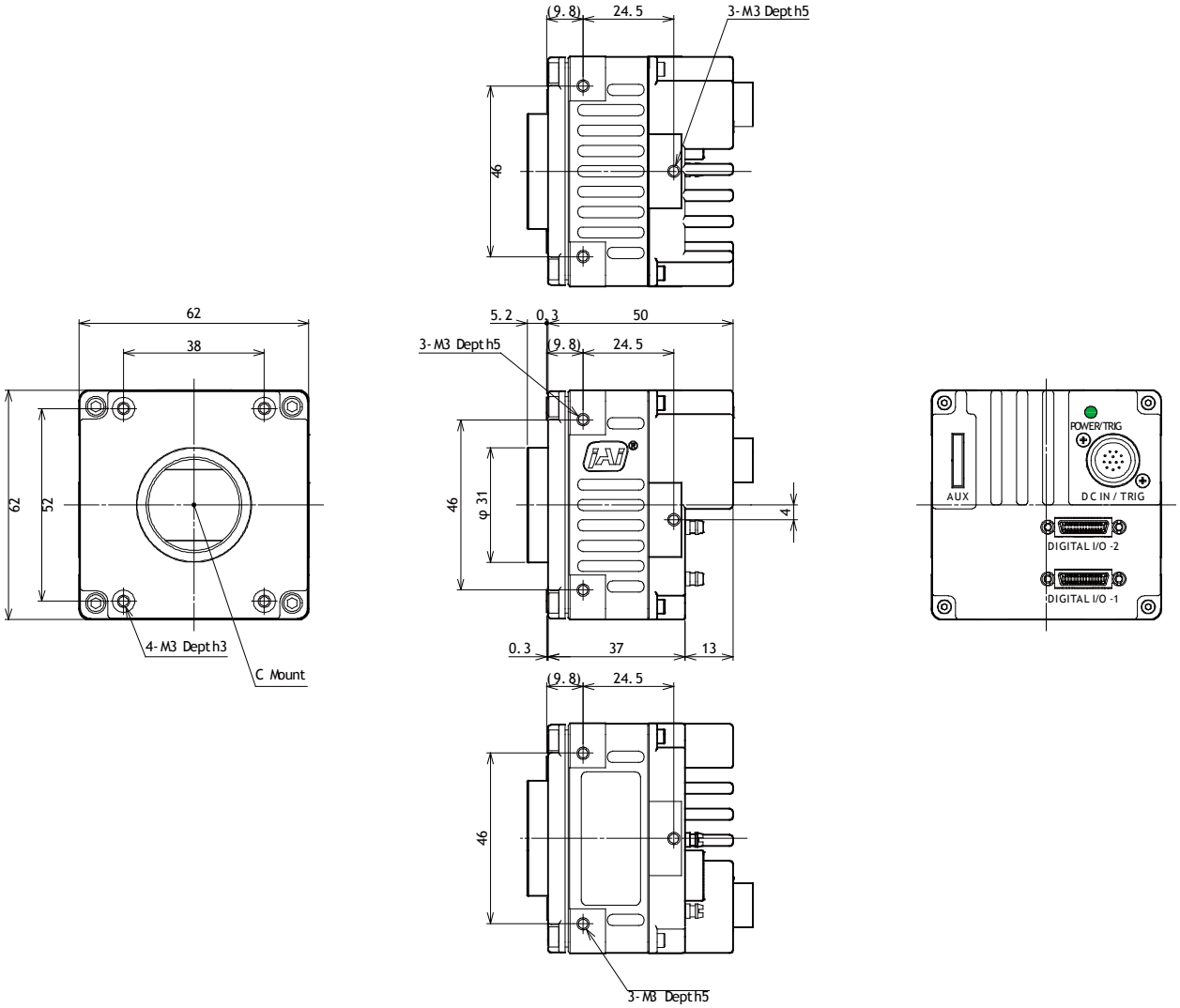
If you need to use the Short ASCII communication protocol and associated control tool, please contact your local JAI representative.

Specific notes regarding Control Tool use:

1. For EL-2800-PMCL, the JAI SDK and Control Tool 2.0 can be used to control the camera, provided the PC on which the JAI software is installed is connected to the camera via a GenCP-compliant Camera Link frame grabber. Many frame grabber vendors also provide their own GenICam control tool software, as do a number of third-party software companies. Software conflicts can occur between these GenICam tools and the JAI SDK and Control Tool causing one or both tools to function improperly. Therefore, if you intend to use the JAI SDK and Control Tool you should A) not install any other GenICam software on your host PC, or B) install the JAI SDK and Control Tool last, after installing any other software. This will, in most cases, ensure that the JAI SDK and Control Tool functions properly. If not, please contact the frame grabber manufacturer or JAI to determine other ways to eliminate any software conflict.

2. The frame grabber used must be compliant with Camera Link Specification v1.1 or greater in order to communicate with the JAI SDK and Control Tool. If it is not, the JAI SDK and Control Tool cannot be used, and the Short ASCII communication protocol and associated control tool should be used instead.

10. External appearance and dimensions



Outside dimensions tolerance : ± 0.3mm

Fig. 46 Outside dimensions

11. Specifications

11.1 Spectral response

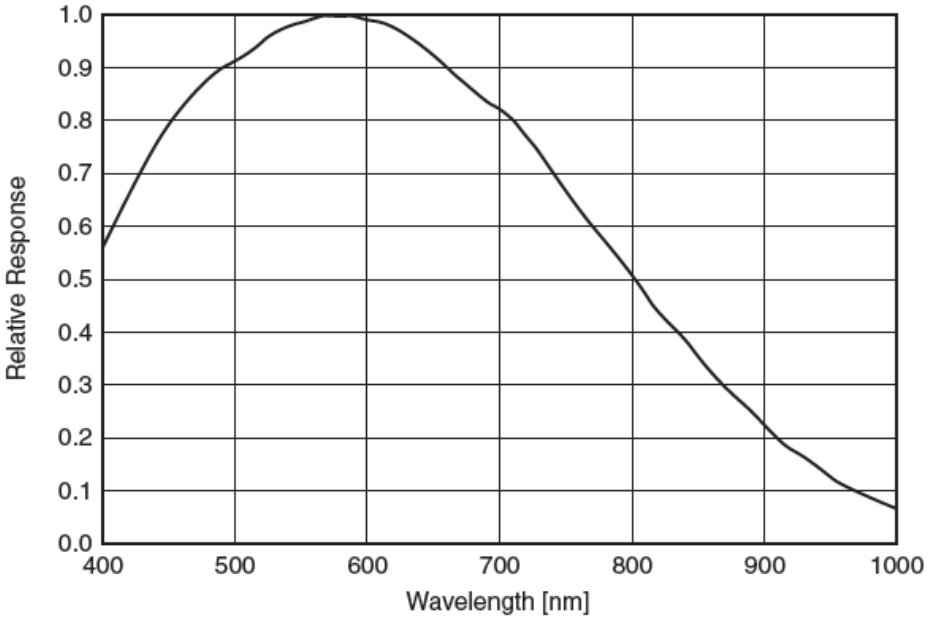


Fig. 47 Spectral response (EL-2800M-PMCL)

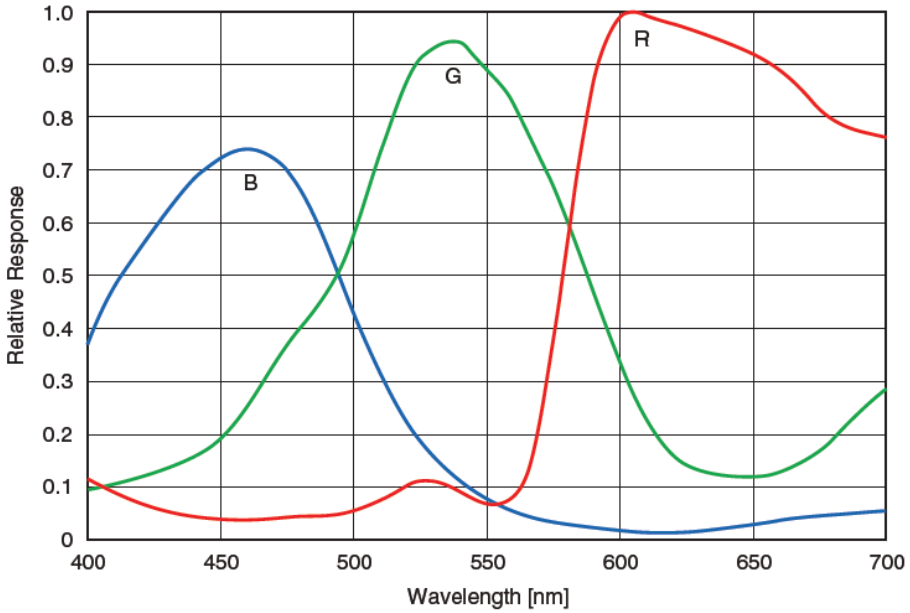


Fig.48 Spectral response (EL-2800C-PMCL)

11.2 Specifications table

Specifications			EL-2800M-PMCL		EL-2800C-PMCL		
Scanning system			Progressive scan, 4-tap				
Synchronization			Internal				
Interface			Camera Link (Version 2.0 RC2) BASE/MEDIUM				
Image sensor			2/3 inch Monochrome CCD		2/3 inch Bayer color CCD		
Aspect Ratio			4:3				
Image size(Effective Image)			8.72 (h) x 6.54 (v) mm 10.972 mm diagonal				
Pixel size			4.54 (h) x 4.54 (v) μm				
Effective Image output Pixels			1920 (h) x 1440 (v)		1920 (h) x 1440 (v)		
Pixel Clock			54 MHz				
Horizontal Frequency	V-Binning	1	Tap Geometry	1X2-2YE, 1X2-1Y	40.693 kHz	1H=24.574 μs	1327clks/line
		1		1X-1Y, 1X-2YE	23.519 kHz	1H=42.519 μs	2296clks/line
		2		1X2-2YE, 1X2-1Y	34.134 kHz	1H=29.296 μs	1582 clks/line
		2		1X-1Y, 1X-2YE	21.160 kHz	1H=47.259 μs	2552 clks/line
Vertical Frequency	V-Binning	1	Tap Geometry	1X2-2YE	54.7 Hz	Total = 744	Effective=720
		1		1X-2YE	31.6 Hz	Total = 744	Effective=720
		1		1X2-1Y	27.4 Hz	Total =1485	Effective=1440
		1		1X-1Y	15.8 Hz	Total =1485	Effective=1440
		2		1X2-2YE	91.0 Hz	Total =375	Effective=360
		2		1X-2YE	47.2 Hz	Total =375	Effective=360
		2		1X2-1Y	45.7 Hz	Total =747	Effective=720
		2		1X-1Y	45.3 Hz	Total =752	Effective=720
Acquisition Frame Rate	1X2-2YE		54.7 fps ～ 0.125 fps		54.7 fps ～ 0.125 fps		
	1X-2YE		31.6 fps ～ 0.125 fps		31.6 fps ～ 0.125 fps		
	1X2-1Y		27.4 fps ～ 0.125 fps		27.4 fps ～ 0.125 fps		
Tap Geometry	1X-1Y		15.8 fps ～ 0.125 fps		15.8 fps ～ 0.125 fps		
	RGB		—		15.8 fps ～ 0.125 fps		
EMVA 1288 Parameters Absolute sensitivity Maximum SNR			at 12-bit output 15.94 p (λ = 525 nm) 41.39dB		at 12-bit output 23.71 p (λ = 525 nm) 41.52dB		
SNR (Traditional method)			61dB (Typical) (0dB gain, Black))		58.5dB (Typical) (0dB gain, Green Black)		
Image Output format Digital	Full image		1920 (h) x 1440 (v)		Bayer 1920 (h) x 1440 (v)		
	ROI	Height OFF SET Y	8 ～1440 lines, 1 line/step		8 ～1440 lines, 2 lines/step		
			0 ～1430 lines, 1 line/step		0 ～1430 lines, 2 lines/step		
	Binning *	H 1	1920 (H)		1920 (H)		
		H 2	960 (H)		–		
		V 1	1440 (V)		1440 (V)		
		V 2	720 (V)		-		
	Bit assignment		8-bit, 10-bit ,12-bit		8-bit , 10-bit ,12-bit, 24-bit_RGB		
Iris Video Out(Analogue)			Video signal 0.7 V p-p, Sync signal 0.3 V (H. sync only)				
Trigger Mode			OFF, Continuous, Timed (EPS), Trigger Width				
Trigger option			PIV, RCT with ALC, RCT w/ALC/Continuous Video output, Trigger Overlap :Readout/OFF, Long time exposure, Sequential trigger				
Trigger Input Signal			Line 1, Line 2, PG1, PG2				

Exposure Mode	Timed (EPS,RCT,PIV Sequential)	10 µs (Min.) ～ 8 sec (Max.)、 Variable unit: 1 µs	
	Trigger Width	1 line + 8 µs (Min.) ～ ～ (Max.)	
Auto Exposure		OFF / Once / Continuous	
Auto Exposure Response Speed		1 ～ 8	
Digital I/O		Line Selector (Hirose 12P): GPIO IN / GPIO OUT	
Black Level Adjust.	Ref. level	33.5LSB 10-bit (Average value of 100*100)	
	Adj. range	-256 ～ 255LSB 10-bit	
	Resolution	1 STEP = 0.25LSB	
Gain Adjust.	Manual Adj. range	-3dB ～+24dB, Less 0.01dB/Step	0dB ～+24dB、Less 0.01dB / step
	WB Gain	—	R / B : -7dB to +13dB, Less 0.01dB/ step
	WB Area	—	4 x 4
	WB Range	—	3000K ～ 9000K
	White Balance	—	OFF, Once, Continuous
Blemish Comp.	Detection	Detect white blemish above the threshold value (Black blemish is detected only by factory)	
	Compensation	Complement by adjacent pixels (Continuous blemishes are not compensated)	
	Numbers	512 pixels (White and black total)	
ALC		AGC, auto exposure, and iris control can be combined and automatically controlled	
Gamma		0.45 ～ 1.0 (8 steps settings are available)	
LUT		OFF: γ=1.0, ON: 256 points can be set	
Shading Compensation		Flat Field Block Comp. (24 x 18 Pixels)	Flat Field, Color shading Block comp. (24 x 18 pixels)
Color interpolation		—	3 x 3 Linear compensation
Power	Input range	DC +12V to +24V ± 10% (At the input terminal)	
	Power Consumption	435mA (At 12V input, full image, lens drive OFF) 460mA (At 12V input, ROI, lens drive OFF)	
		5.22W (At 12V input, full image, lens drive OFF) 5.52W (At 12V input, ROI, lens drive OFF)	
Lens mount		C mount, Rear protrusion of the lens is less than10 mm.	
Flange back		C mount : 17.526 mm, Tolerance : 0 to -0.05 mm	
Optical filter		Protection glass : Not provided	Optical Low Pass filter ＋ IR cut filter (Half value is 670nm)
Operating temperature/ Humidity Performance guaranteed		-5°C to +45°C / 20 – 80% (No-condensing)	
Operating temperature/ Humidity		-45° to +70° / 20 – 80% (No-condensing)	
Storage Temp. / Humidity		-45°C to +70°C/20% to 80 % (no-condensing)	
Regulation		CE (EN61000-6-2 and EN61000-6-3), FCC part 15 class B, RoHS, WEEE	
Housing Dimensions		62 x 62 x 55.5 mm (W x H x D) (excluding protrusion)	
Weight		215 g	

Note1): Approximately 5 minutes pre-heating is required to achieve these specifications.
Note2): The above specifications are subject to change without notice.

Appendix 1 Short ASCII Command Communication Protocol

This chapter described the communication control protocol based on the short ASCII command as the reference.

1. Communication setting

Baud Rate	9600
Data Length	8bit
Start Bit	1bit
Stop Bit	1bit
Parity	Non
Xon/Xoff Control	Non

2. Protocol（Short ASCII Command）

2.1 Transmit the setting command to camera

NN is any kind of the commands.
NN=[Param.]<CR><LF>
e.g.
Send to camera: GA=0 <CR><LF>
Camera response: COMPLETE<CR><LF>

When camera receives the valid command, camera will return 'COMPLETE'.
If camera receives the command, camera will return following:
e.g.
Send to camera: GAX=0 <CR><LF>
Camera response: 01 Unknown Command!!<CR><LF>
e.g.
Send to camera: GA=1000 <CR><LF>
Camera response: 02 Bad Parameters!!<CR><LF>

2.2 Transmit the request command to camera

The status of camera's settings can be queried by transmitting NN?<CR><LF>, where NN is any kind of the commands.
The camera will return the current setting data.
e.g.
Send to camera: GA? <CR><LF>
Camera response: GA=0<CR><LF>

2.3 Switching baud rate between PC and camera

Camera always starts up with 9600bps. This can be switched to higher baud rates after a communication has been established. When switching to other baud rate the procedure is as follows.

e.g. Change baud rate to 115200bps

1. Confirm baud rates camera supported
   Send to camera: SBDRT? <CR><LF>
   Camera response: SBDRT=31(0x1F)<CR><LF>

2. Request new baud rate
   Send to camera: CBDRT=16(0x10) <CR><LF>
   Camera response: COMPLETE<CR><LF>

(Change baud rate to 115200bps)

3. Rewrite new baud rate again with new baud rate (Confirmation command)
   Send to camera: CBDRT=16(0x10) <CR><LF>
   Camera response: COMPLETE<CR><LF>

   In case the camera does not receive the confirming command with new baud rate within 250ms after sending the acknowledge it falls back to the original baud rate (9600bps).

2.4 Command list (Short ASCII command)

2.4.1 GenCP Bootstrap Register

Name	Interface	Access	Short ASCII	Values	MIN	MAX	DEFAULT	Description
DeviceVendorName	I String	R/O	DVN	"JAI Ltd., Japan"	—	—	—	**DVN**?<CR><LF>
DeviceModelName	I String	R/O	MD		—	—	—	**MD**?<CR><LF>
DeviceVersion	I String	R/O	DV	Indicate device version (e.g. "0.1.0.0")	—	—	—	**DV**?<CR><LF>
DeviceID	I String	R/O	ID	Serial Number	—	—	—	**ID**?<CR><LF>
DeviceUserID	I String	R/W	UD	User can save and load free text. (12 or less characters)				**UD**=[Param.]<CR><LF> UD?<CR><LF>

2.4.2 Technology Specific Bootstrap Register

Name	Interface	Access	Short ASCII	Values	MIN	MAX	DEFAULT	Description
SupportedBaudrates	I Integer	R/O	SBDRT	Indicate Support/Non-support status for each baud rate bit0: 9600bps bit1: 19200bps bit2: 38400bps bit3: 57600bps bit4: 115200bps bit5: 230400bps bit6: 460800bps bit7: 921600bps	0x01	0xFF	0x1F	**SBDRT**?<CR><LF>
CurrentBaudrate	I Integer	R/W	CBDRT	READ: Indicate current baud rate WRITE: Set any bit of baud rate bit0: 9600bps bit1: 19200bps bit2: 38400bps bit3: 57600bps bit4: 115200bps bit5: 230400bps bit6: 460800bps bit7: 921600bps	0x01	0x80	1 (9600bps)	**CBDRT**=[Param.]<CR><LF> CBDRT?<CR><LF> In case of WRITE execution (change baud rate), it needs to control in the proper sequence between Host and Camera. (Refer to the section 3.3)

2.4.3 Device Control

Name	Interface	Access	Short ASCII	Values	MIN	MAX	DEFAULT	Description
DeviceFirmware Version	I String	R/O	VN	Firm Ver. No.	—	—	—	**VN**?<CR><LF>
DeviceReset	I Command	W/O	CRS00	1	—	—	—	**CRS00=1<CR><LF>**

2.4.4 Image Format Control

Name	Interface	Access	Short ASCII	Values	MIN	MAX	DEFAULT	Description
Height	I Integer	R/W	HTL	Min～(Max - OffsetY)	8	1440	1440	**HTL**=[Param.]<CR><LF> HTL?<CR><LF>
Offset Y	I Integer	R/W	OFL	Min～(Max – Height)	0	1432	0	**OFL**=[Param.]<CR><LF> OFL?<CR><LF> This value is calcurated automatically for centering of picture during 1X-2YE, 1X2-2YE mode.
BinningHorizontal	I Integer	R/W	HB	1: Normal / 2: Binning mode	1	2	1	**HB**=[Param.]<CR><LF> HB?<CR><LF> only Mono
BinningVertical	I Integer	R/W	VB	1: Normal / 2: Binning mode	1	2	1	**VB**=[Param.]<CR><LF> VB?<CR><LF> only Mono
PixelFormat	I Enumeration	R/(W)	BA	Mono model: 0: Mono8 1: Mono10 2: Mono12 Bayer model: 0: BayerRG8 1: BayerRG10 2: BayerRG12	0	2	0	**BA**=[Param.]<CR><LF> BA?<CR><LF>
TestImageSelector	I Enumeration	R/W	TPN	0: Off 1: GreyHorizontalRamp 2: GreyVerticalRamp 3: GreyHorizontalRampMoving 4: Horizontal Colorbar* 5: Vertical Colorbar* 6: Moving Colorbar* (* Bayer model only)	0	7	0	**TPN**=[Param.]<CR><LF> TPN?<CR><LF>

2.4.5 Acquisition Control

Name	Interface	Access	Short ASCII	Values	MIN	MAX	DEFAULT	Description
FrameStartTrigMode	I Enumeration	R/W	TM	Off/On	0	1	0	**TM**=[Param.]<CR><LF> TM?<CR><LF>
TrigSoftware	I Command	(R)/W	STRG	0	—	—	—	**STRG**=0<CR><LF>
FrameStartTrigSource	I Enumeration	R/W	TI	0: Low 1: High 2: SoftTrigger 8: PulseGenerator0 9: PulseGenerator1 10: PulseGenerator2 11: PulseGenerator3 12: TTL_In1 13: CL_CC1_In 14: Nand0 15: Nand1 16: TTL_In2(Option) 17: LVDS_In(Option)	0	17	0	**TI**=[Param.]<CR><LF> TI?<CR><LF>
FrameStartTrigActivation	I Enumeration	R/W	TA	0: RisingEdge 1: FallingEdge 2: LevelHigh 3: LevelLow	0	3	0	**TA**=[Param.]<CR><LF> TA?<CR><LF>
FrameStartTrigOver Lap	I Enumeration	R/W	TO	0: Off / 1: ReadOut	0	1	0	**TO**=[Param.]<CR><LF> TO?<CR><LF>
ExposureMode	I Enumeration	R/W	EM	0: Off 1: Timed 2: TriggerWidth	0	2	0	**EM**=[Param.]<CR><LF> EM?<CR><LF>
ExposureTimeRaw	I Integer	R/W	PE	Min~Max[us]	12	8000000	18000	**PE**=[Param.]<CR><LF> PE?<CR><LF>
ExposureAuto	I Enumeration	R/W	ASC	0: Off 2: Once 1: Continuous	0	2	2	**ASC**=[Param.]<CR><LF> ASC?<CR><LF>

2.4.6 Digital I/O Control

Name	Interface	Access	Short ASCII	Values	MIN	MAX	DEFAULT	Description
LineInverter_Line1	I Boolean	R/W	LI0	False/True	0	1	0	**LI0**=[Param.]<CR><LF> LI0?<CR><LF>
LineInverter_Line8	I Boolean	R/W	LI1	False/True	0	1	0	**LI1**=[Param.]<CR><LF> LI1?<CR><LF>
LineInverter_Line9	I Boolean	R/W	LI2	False/True	0	1	0	**LI2**=[Param.]<CR><LF> LI2?<CR><LF>
LineInverter_Nand0In1	I Boolean	R/W	ND0INV1	False/True	0	1	0	**ND0INV1**=[Param.]<CR><LF> ND0INV1?<CR><LF>
LineInverter_Nand0In2	I Boolean	R/W	ND0INV2	False/True	0	1	0	**ND0INV2**=[Param.]<CR><LF> ND0INV2?<CR><LF>
LineInverter_Nand1In1	I Boolean	R/W	ND1INV1	False/True	0	1	0	**ND1INV1**=[Param.]<CR><LF> ND0INV1?<CR><LF>

LineInverter_Nand1In2	I Boolean	R/W	ND1INV2	False/True	0	1	0	**ND1INV2**=[Param.]<CR><LF> ND0INV2?<CR><LF>
LineSource_Line1	I Enumeration	R/W	LS0	0: Low 1: High 3: FrameTriggerWait 4: FrameActive 5: ExposureActive 6: Fval 7: Lval 8: PulseGenerator0 9: PulseGenerator1 10: PulseGenerator2 11: PulseGenerator3 12: TTL_In 13: CL_CC1_In 14: Nand0 15: Nand1 16: TTL_In2(Option) 17: LVDS_In(Option)	0	17	0	**LS0**=[Param.]<CR><LF> LS0?<CR><LF> For 12pin TTL out
LineSource_Line8	I Enumeration	R/W	LS1	Same as for Line1	0	17	0	**LS1**=[Param.]<CR><LF> LS1?<CR><LF> For Option TTL out
LineSource_Line9	I Enumeration	R/W	LS2	Same as for Line1	0	17	0	**LS2**=[Param.]<CR><LF> LS2?<CR><LF> For Option TTL out
LineSource_Nand0In1	I Enumeration	R/W	ND0IN1	Same as for Line1	0	17	0	**ND0IN1**=[Param.]<CR><LF> ND0IN1?<CR><LF>
LineSource_Nand0In2	I Enumeration	R/W	ND0IN2	Same as for Line1	0	17	0	**ND0IN2**=[Param.]<CR><LF> ND0IN2?<CR><LF>
LineSource_Nand1In1	I Enumeration	R/W	ND1IN1	Same as for Line1	0	17	0	**ND1IN1**=[Param.]<CR><LF> ND1IN1?<CR><LF>
LineSource_Nand1In2	I Enumeration	R/W	ND1IN2	Same as for Line1	0	17	0	**ND1IN2**=[Param.]<CR><LF> ND1IN2?<CR><LF>

2.4.7 Analog Control

Name	Interface	Access	Short ASCII	Values	MIN	MAX	DEFAULT	Description
GainRawAnalogAll	I Integer	R/W	GA	min~0~max	-84 (mono) 0 (Bayer)	672	0	**GA**=[Param.]<CR><LF> GA?<CR><LF>
GainRawDigitalAll	I Integer	R/W	FGA	min~0~max	-2393	3379	0	**FGA**=[Param.]<CR><LF> FGA?<CR><LF>
GainRawDigitalRedAll	I Integer	R/W	PGR	min~0~max	-4533	28400	0	**PGR**=[Param.]<CR><LF> PGR?<CR><LF> (Bayer model only)
GainRawDigitalBlueAll	I Integer	R/W	PGB	min~0~max	-4533	28400	0	**PGB**=[Param.]<CR><LF> PGB?<CR><LF> (Bayer model only)
GainRawDigitalTap2All	I Integer	R/W	GJUT2	min~0~max	-891	1000	0	**GJUT2**=[Param.]<CR><LF> GJUT2?<CR><LF>
GainRawDigitalTap2 Red	I Integer	R/W	PGR2	min~0~max	-891	1000	0	**PGR2**=[Param.]<CR><LF> PGR2?<CR><LF> (Bayer model only)
GainRawDigitalTap2 Blue	I Integer	R/W	PGB2	min~0~max	-891	1000	0	**PGB2**=[Param.]<CR><LF> PGB2?<CR><LF> (Bayer model only)
GainRawDigitalTap3All	I Integer	R/W	GJUT3	min~0~max	-891	1000	0	**GJUT3**=[Param.]<CR><LF> GJUT3?<CR><LF>
GainRawDigitalTap3 Red	I Integer	R/W	PGR3	min~0~max	-891	1000	0	**PGR3**=[Param.]<CR><LF> PGR3?<CR><LF> (Bayer model only)
GainRawDigitalTap3 Blue	I Integer	R/W	PGB3	min~0~max	-891	1000	0	**PGB3**=[Param.]<CR><LF> PGB3?<CR><LF> (Bayer model only)
GainRawDigitalTap4All	I Integer	R/W	GJUT4	min~0~max	-891	1000	0	**GJUT4**=[Param.]<CR><LF> GJUT4?<CR><LF>
GainRawDigitalTap4 Red	I Integer	R/W	PGR4	min~0~max	-891	1000	0	**PGR4**=[Param.]<CR><LF> PGR4?<CR><LF> (Bayer model only)
GainRawDigitalTap4 Blue	I Integer	R/W	PGB4	min~0~max	-891	1000	0	**PGB4**=[Param.]<CR><LF> PGB4?<CR><LF> (Bayer model only)
GainAuto	I Enumeration	R/W	AGC	0: Off 1: Continuous 2: Once	0	2	0	**AGC**=[Param.]<CR><LF> AGC?<CR><LF>
GainAutoBalance	I Enumeration	R/W	AWA	0: Off 1: Once 2: Continuous	0	2	0	**AWA**=[Param.]<CR><LF> AWA?<CR><LF>
BlackLevelRawAll	I Integer	R/W	BL	min~0~max	-256	255	0	**BL**=[Param.]<CR><LF> BL?<CR><LF>
BlackLevelRawTap1All	I Integer	R/W	BL1	min~0~max	-512	511	0	**BL1**=[Param.]<CR><LF> BL1?<CR><LF>
BlackLevelRawTap1 Red	I Integer	R/W	BLR1	min~0~max	-512	511	0	**BLR1**=[Param.]<CR><LF>

								BLR1?<CR><LF> (Bayer model only)
BlackLevelRawTap1 Blue	I Integer	R/W	BLB1	min～0～max	-512	511	0	**BLB1**=[Param.]<CR><LF> BLB1?<CR><LF> (Bayer model only)
BlackLevelRawTap2All	I Integer	R/W	BL2	min～0～max	-512	511	0	**BL2**=[Param.]<CR><LF> BL2?<CR><LF>
BlackLevelRawTap2 Red	I Integer	R/W	BLR2	min～0～max	-512	511	0	**BLR2**=[Param.]<CR><LF> BLR2?<CR><LF> (Bayer model only)
BlackLevelRawTap2 Blue	I Integer	R/W	BLB2	min～0～max	-512	511	0	**BLB2**=[Param.]<CR><LF> BLB2?<CR><LF> (Bayer model only)
BlackLevelRawTap3All	I Integer	R/W	BL3	min～0～max	-512	511	0	**BL3**=[Param.]<CR><LF> BL3?<CR><LF>
BlackLevelRawTap3 Red	I Integer	R/W	BLR3	min～0～max	-512	511	0	**BLR3**=[Param.]<CR><LF> BLR3?<CR><LF> (Bayer model only)
BlackLevelRawTap3 Blue	I Integer	R/W	BLB3	min～0～max	-512	511	0	**BLB3**=[Param.]<CR><LF> BLB3?<CR><LF> (Bayer model only)
BlackLevelRawTap4All	I Integer	R/W	BL4	min～0～max	-512	511	0	**BL4**=[Param.]<CR><LF> BL4?<CR><LF>
BlackLevelRawTap4 Red	I Integer	R/W	BLR4	min～0～max	-512	511	0	**BLR4**=[Param.]<CR><LF> BLR4?<CR><LF> (Bayer model only)
BlackLevelRawTap4 Blue	I Integer	R/W	BLB4	min～0～max	-512	511	0	**BLB4**=[Param.]<CR><LF> BLB4?<CR><LF> (Bayer model only)
BlackLevelAutoBalance	I Enumeration	R/W	ABA	0: Off 1: Once	Off	Once	Off	**ABA**=[Param.]<CR><LF> ABA?<CR><LF>
BalanceWhiteAuto	I Enumeration	R/W	AWB	0: Off 2: Once 1: Continuous	0	2	0	**AWB**=[Param.]<CR><LF> AWB?<CR><LF> (Bayer model only)

2.4.8 LUT Control

Name	Interface	Access	Short ASCII	Values	MIN	MAX	DEFAULT	Description
LUTValueRed	I Integer	R/W	LUTR	Param 1: LUT index Param 2:LUTdata(Min～Max) (Bayer model only)	0	4095	γ=1 相当値	**LUT*=[Param1],[Param2]<CR><LF>** LUT*?[Param1]<CR><LF>
LUTValueGreen	I Integer	R/W	LUTG	Param 1: LUT index Param 2:LUTdata(Min～Max)	0	4095		
LUTValueBlue	I Integer	R/W	LUTB	Param 1: LUT index Param 2:LUTdata(Min～Max) (Bayer model only)	0	4095		

2.4.9 Transport Layer Control

Name	Interface	Access	Short ASCII	Values	MIN	MAX	DEFAULT	Description
DeviceTapGeometry	I Enumeration	R/(W)	TAGM	0: Geometry_1X_1Y 1: Geometry_1X2_1Y 3: Geometry_1X_2YE 6: Geometry_1X2_2YE	0	6	6	**TAGM**=[Param.]<CR><LF> TAGM?<CR><LF>

2.4.10 User Set Control

Name	Interface	Access	Short ASCII	Values	MIN	MAX	DEFAULT	Description
UserSetLoad	I Command	(R)/W	LD	0: Default 1: UserSet1 2: UserSet2 3: UserSet3	0	3	0	**LD**=[Param.]<CR><LF> LD?<CR><LF>
UserSetSave	I Command	(R)/W	SA	1: UserSet1 2: UserSet2 3: UserSet3	1	3	1	**SA**=[Param.]<CR><LF> SA?<CR><LF>

2.4.11 JAI-Custom

Name	Interface	Access	Short ASCII	Values	MIN	MAX	DEFAULT	Description
BlemishWhiteEnable	I Boolean	R/W	BMW	0: False 1: True	0	1	0	**BMW**=[Param.]<CR><LF> BMW?<CR><LF>
BlemishWhiteDetect	I Command	W/O	BMRCW	0	0	0	0	**BMRCW**=0<CR><LF>
BlemishWhiteDetectThreshold	I Integer	R/W	BMTHW	0	0	100	10	**BMTHW**=[Param.]<CR><LF> BMTHW?<CR><LF>
BlemishWhiteDetectPositionX	I Integer	R/W	BMPXW	Param 1: Blemish index Param 2: X position(Min～Max)	0	1919	0	**BMPXW**=[Param1],[Param2]<CR><LF> BMPXW?[Param1]<CR><LF>
BlemishWhiteDetectPositionY	I Integer	R/W	BMPYW	Param 1: Blemish index Param 2: Y position(Min～Max)	0	1439	0	**BMPYW**=[Param1],[Param2]<CR><LF> BMPYW?[Param1]<CR><LF>
ShadingCorrection Mode	I Enumeration	R/W	SDCM	0: Flat Shading 1: Color Shading* (*Bayer model only)	0	1	0	**SDCM**=[Param.]<CR><LF> SDCM?<CR><LF>
ShadingCorrect	I Command	W/O	RS		0	0	0	**BMRCW**=0<CR><LF>
RequestShadingDetectResult	I Enumeration	R/O	SDRS	0=Complete. 1=Too Bright. 2=Too dark. 3=Timeout Error. 4=Busy. 5=Limit. 6= Trig is not set as Normal.	0	6	0	**SDRS**?<CR><LF>
ShadingMode	I Enumeration	R/W	SDM	0: OFF 1: User 1 2: User 2 3: User 3	0	3	0	**SDM**=[Param.]<CR><LF> SDM?<CR><LF>
VideoSendMode	I Enumeration	R/W	VSM	0: Normal 1: Trigger Sequence 2: Command Sequence	0	2	0	**VSM**=[Param.]<CR><LF> VSM?<CR><LF>
SequenceModeIndex	I Enumeration	R/W	SQI	0: Index0 1: Index1 2: Index2 3: Index3 4: Index4 5: Index5 6: Index6 7: Index7 8: Index8 9: Index9	0	9	0	**SQI**=[Param.]<CR><LF> SQI?<CR><LF>
SequenceModeFrameCount0	I Integer	R/W	SQF1	Min～Max	1	255	1	**SQF1**=[Param.]<CR><LF> SQI1?<CR><LF>
SequenceModeFrameCount1	I Integer	R/W	SQF2	Min～Max	1	255	1	**SQF2**=[Param.]<CR><LF> SQI2?<CR><LF>
SequenceNodeFrameCount2	I Integer	R/W	SQF3	Min～Max	1	255	1	**SQF3**=[Param.]<CR><LF> SQI3?<CR><LF>

SequenceMode Frame Count3	I Integer	R/W	SQF4	Min～Max	1	255	1	**SQF4**=[Param.]<CR><LF> SQI4?<CR><LF>
SequenceMode Frame Count4	I Integer	R/W	SQF5	Min～Max	1	255	1	**SQF5**=[Param.]<CR><LF> SQI5?<CR><LF>
SequenceMode Frame Count5	I Integer	R/W	SQF6	Min～Max	1	255	1	**SQF6**=[Param.]<CR><LF> SQI6?<CR><LF>
SequenceMode Frame Count6	I Integer	R/W	SQF7	Min～Max	1	255	1	**SQF7**=[Param.]<CR><LF> SQI7?<CR><LF>
SequenceMode Frame Count7	I Integer	R/W	SQF8	Min～Max	1	255	1	**SQF8**=[Param.]<CR><LF> SQI8?<CR><LF>
SequenceMode Frame Count8	I Integer	R/W	SQF9	Min～Max	1	255	1	**SQF9**=[Param.]<CR><LF> SQI9?<CR><LF>
SequenceMode Frame Count9	I Integer	R/W	SQF10	Min～Max	1	255	1	**SQF10**=[Param.]<CR><LF> SQI10?<CR><LF>
SequenceMode Next Index0	I Enumeration	R/W	SQNI1	Same as SequenceRoiIndex	0	9	0	**SQNI1**=[Param.]<CR><LF> SQNI1?<CR><LF>
SequenceMode Next Index1	I Enumeration	R/W	SQNI2	Same as SequenceRoiIndex	0	9	0	**SQNI2**=[Param.]<CR><LF> SQNI2?<CR><LF>
SequenceMode Next Index2	I Enumeration	R/W	SQNI3	Same as SequenceRoiIndex	0	9	0	**SQNI3**=[Param.]<CR><LF> SQNI3?<CR><LF>
SequenceMode Next Index3	I Enumeration	R/W	SQNI4	Same as SequenceRoiIndex	0	9	0	**SQNI4**=[Param.]<CR><LF> SQNI4?<CR><LF>
SequenceMode Next Index4	I Enumeration	R/W	SQNI5	Same as SequenceRoiIndex	0	9	0	**SQNI5**=[Param.]<CR><LF> SQNI5?<CR><LF>
SequenceMode Next Index5	I Enumeration	R/W	SQNI6	Same as SequenceRoiIndex	0	9	0	**SQNI6**=[Param.]<CR><LF> SQNI6?<CR><LF>
SequenceMode Next Index6	I Enumeration	R/W	SQNI7	Same as SequenceRoiIndex	0	9	0	**SQNI7**=[Param.]<CR><LF> SQNI7?<CR><LF>
SequenceMode Next Index7	I Enumeration	R/W	SQNI8	Same as SequenceRoiIndex	0	9	0	**SQNI8**=[Param.]<CR><LF> SQNI8?<CR><LF>
SequenceMode Next Index8	I Enumeration	R/W	SQNI9	Same as SequenceRoiIndex	0	9	0	**SQNI9**=[Param.]<CR><LF> SQNI9?<CR><LF>
SequenceMode Next Index9	I Enumeration	R/W	SQNI10	Same as SequenceRoiIndex	0	9	0	**SQNI10**=[Param.]<CR><LF> SQNI10?<CR><LF>
SequenceMode Height0	I Integer	R/W	SQH1	Min～Max	8	1440	1440	**SQH1**=[Param.]<CR><LF> SQH1?<CR><LF>
SequenceMode Height1	I Integer	R/W	SQH2	Min～Max	8	1440	1440	**SQH2**=[Param.]<CR><LF> SQH2?<CR><LF>
SequenceMode Height2	I Integer	R/W	SQH3	Min～Max	8	1440	1440	**SQH3**=[Param.]<CR><LF> SQH3?<CR><LF>

SequenceMode Height3	I Integer	R/W	SQH4	Min～Max	8	1440	1440	**SQH4**=[Param.]<CR><LF> SQH4?<CR><LF>
SequenceMode Height4	I Integer	R/W	SQH5	Min～Max	8	1440	1440	**SQH5**=[Param.]<CR><LF> SQH5?<CR><LF>
SequenceMode Height5	I Integer	R/W	SQH6	Min～Max	8	1440	1440	**SQH6**=[Param.]<CR><LF> SQH6?<CR><LF>
SequenceMode Height6	I Integer	R/W	SQH7	Min～Max	8	1440	1440	**SQH7**=[Param.]<CR><LF> SQH7?<CR><LF>
SequenceMode Height7	I Integer	R/W	SQH8	Min～Max	8	1440	1440	**SQH8**=[Param.]<CR><LF> SQH8?<CR><LF>
SequenceMode Height8	I Integer	R/W	SQH9	Min～Max	8	1440	1440	**SQH9**=[Param.]<CR><LF> SQH9?<CR><LF>
SequenceMode Height9	I Integer	R/W	SQH10	Min～Max	8	1440	1440	**SQH10**=[Param.]<CR><LF> SQH10?<CR><LF>
SequenceMode OffsetY0	I Integer	R/W	SQOY1	Min～Max	0	1432	0	**SQOY1**=[Param.]<CR><LF> SQOY1?<CR><LF>
SequenceMode OffsetY1	I Integer	R/W	SQOY2	Min～Max	0	1432	0	**SQOY2**=[Param.]<CR><LF> SQOY2?<CR><LF>
SequenceMode OffsetY2	I Integer	R/W	SQOY3	Min～Max	0	1432	0	**SQOY3**=[Param.]<CR><LF> SQOY3?<CR><LF>
SequenceMode OffsetY3	I Integer	R/W	SQOY4	Min～Max	0	1432	0	**SQOY4**=[Param.]<CR><LF> SQOY4?<CR><LF>
SequenceMode OffsetY4	I Integer	R/W	SQOY5	Min～Max	0	1432	0	**SQOY5**=[Param.]<CR><LF> SQOY5?<CR><LF>
SequenceMode OffsetY5	I Integer	R/W	SQOY6	Min～Max	0	1432	0	**SQOY6**=[Param.]<CR><LF> SQOY6?<CR><LF>
SequenceMode OffsetY6	I Integer	R/W	SQOY7	Min～Max	0	1432	0	**SQOY7**=[Param.]<CR><LF> SQOY7?<CR><LF>
SequenceMode OffsetY7	I Integer	R/W	SQOY8	Min～Max	0	1432	0	**SQOY8**=[Param.]<CR><LF> SQOY8?<CR><LF>
SequenceMode OffsetY8	I Integer	R/W	SQOY9	Min～Max	0	1432	0	**SQOY9**=[Param.]<CR><LF> SQOY9?<CR><LF>
SequenceMode OffsetY9	I Integer	R/W	SQOY10	Min～Max	0	1432	0	**SQOY10**=[Param.]<CR><LF> SQOY10?<CR><LF>
SequenceMode Gain0	I Integer	R/W	SQGA1	Min～Max	-84 (mono) 0 (Bayer)	672	0	**SQGA1**=[Param.]<CR><LF> SQGA1?<CR><LF>
SequenceMode Gain1	I Integer	R/W	SQGA2	Min～Max	-84 (mono) 0 (Bayer)	672	0	**SQGA2**=[Param.]<CR><LF> SQGA2?<CR><LF>
SequenceMode Gain2	I Integer	R/W	SQGA3	Min～Max	-84 (mono) 0 (Bayer)	672	0	**SQGA3**=[Param.]<CR><LF> SQGA3?<CR><LF>
SequenceMode Gain3	I Integer	R/W	SQGA4	Min～Max	-84 (mono)	672	0	**SQGA4**=[Param.]<CR><LF>

					0 Bayer)			SQGA4?<CR><LF>
SequenceMode Gain4	I Integer	R/W	SQGA5	Min～Max	-84 (mono) 0 (Bayer)	672	0	**SQGA5**=[Param.]<CR><LF> SQGA5?<CR><LF>
SequenceMode Gain5	I Integer	R/W	SQGA6	Min～Max	-84 (mono) 0 (Bayer)	672	0	**SQGA6**=[Param.]<CR><LF> SQGA6?<CR><LF>
SequenceMode Gain6	I Integer	R/W	SQGA7	Min～Max	-84 (mono) 0 (Bayer)	672	0	**SQGA7**=[Param.]<CR><LF> SQGA7?<CR><LF>
SequenceMode Gain7	I Integer	R/W	SQGA8	Min～Max	-84 (mono) 0 (Bayer)	672	0	**SQGA8**=[Param.]<CR><LF> SQGA8?<CR><LF>
SequenceMode Gain8	I Integer	R/W	SQGA9	Min～Max	-84 (mono) 0 (Bayer)	672	0	**SQGA9**=[Param.]<CR><LF> SQGA9?<CR><LF>
SequenceMode Gain9	I Integer	R/W	SQGA10	Min～Max	-84 (mono) 0 (Bayer)	672	0	**SQGA10**=[Param.]<CR><LF> SQGA10?<CR><LF>
SequenceMode ExposureTime 0	I Integer	R/W	SQPE1	Min～Max	10	800000	18000	**SQPE1**=[Param.]<CR><LF> SQPE1?<CR><LF>
SequenceMode ExposureTime 1	I Integer	R/W	SQPE2	Min～Max	10	800000	18000	**SQPE2**=[Param.]<CR><LF> SQPE2?<CR><LF>
SequenceMode ExposureTime 2	I Integer	R/W	SQPE3	Min～Max	10	800000	18000	**SQPE3**=[Param.]<CR><LF> SQPE3?<CR><LF>
SequenceMode ExposureTime 3	I Integer	R/W	SQPE4	Min～Max	10	800000	18000	**SQPE4**=[Param.]<CR><LF> SQPE4?<CR><LF>
SequenceMode ExposureTime 4	I Integer	R/W	SQPE5	Min～Max	10	800000	18000	**SQPE5**=[Param.]<CR><LF> SQPE5?<CR><LF>
SequenceMode ExposureTime 5	I Integer	R/W	SQPE6	Min～Max	10	800000	18000	**SQPE6**=[Param.]<CR><LF> SQPE6?<CR><LF>
SequenceMode ExposureTime 6	I Integer	R/W	SQPE7	Min～Max	10	800000	18000	**SQPE7**=[Param.]<CR><LF> SQPE7?<CR><LF>
SequenceMode ExposureTime 7	I Integer	R/W	SQPE8	Min～Max	10	800000	18000	**SQPE8**=[Param.]<CR><LF> SQPE8?<CR><LF>
SequenceMode ExposureTime 8	I Integer	R/W	SQPE9	Min～Max	10	800000	18000	**SQPE9**=[Param.]<CR><LF> SQPE9?<CR><LF>
SequenceMode ExposureTime 9	I Integer	R/W	SQPE10	Min～Max	10	800000	18000	**SQPE10**=[Param.]<CR><LF> SQPE10?<CR><LF>
SequenceMode Hbinning0	I Enumeration	R/W	SQHB1	1: Hbinning = OFF 2: Hbinning = ON	1	2	1	**SQHB1**=[Param.]<CR><LF> SQHB1?<CR><LF> (Mono model only)
SequenceMode Hbinning1	I Enumeration	R/W	SQHB2	1: Hbinning = OFF 2: Hbinning = ON	1	2	1	**SQHB2**=[Param.]<CR><LF> SQHB2?<CR><LF> (Mono model only)
SequenceMode Hbinning2	I Enumeration	R/W	SQHB3	1: Hbinning = OFF 2: Hbinning = ON	1	2	1	**SQHB3**=[Param.]<CR><LF> SQHB3?<CR><LF>

								(Mono model only)
SequenceModeHbinning3	I Enumeration	R/W	SQHB4	1: Hbinning = OFF 2: Hbinning = ON	1	2	1	**SQHB4**=[Param.]<CR><LF> SQHB4?<CR><LF> (Mono model only)
SequenceModeHbinning4	I Enumeration	R/W	SQHB5	1: Hbinning = OFF 2: Hbinning = ON	1	2	1	**SQHB5**=[Param.]<CR><LF> SQHB5?<CR><LF> (Mono model only)
SequenceModeHbinning5	I Enumeration	R/W	SQHB6	1: Hbinning = OFF 2: Hbinning = ON	1	2	1	**SQHB6**=[Param.]<CR><LF> SQHB6?<CR><LF> (Mono model only)
SequenceModeHbinning6	I Enumeration	R/W	SQHB7	1: Hbinning = OFF 2: Hbinning = ON	1	2	1	**SQHB7**=[Param.]<CR><LF> SQHB7?<CR><LF> (Mono model only)
SequenceModeHbinning7	I Enumeration	R/W	SQHB8	1: Hbinning = OFF 2: Hbinning = ON	1	2	1	**SQHB8**=[Param.]<CR><LF> SQHB8?<CR><LF> (Mono model only)
SequenceModeHbinning8	I Enumeration	R/W	SQHB9	1: Hbinning = OFF 2: Hbinning = ON	1	2	1	**SQHB9**=[Param.]<CR><LF> SQHB9?<CR><LF> (Mono model only)
SequenceModeHbinning9	I Enumeration	R/W	SQHB10	1: Hbinning = OFF 2: Hbinning = ON	1	2	1	**SQHB10**=[Param.]<CR><LF> SQHB10?<CR><LF> (Mono model only)
SequenceModeVbinning0	I Enumeration	R/W	SQVB1	1: Hbinning = OFF 2: Hbinning = ON	1	2	1	**SQVB1**=[Param.]<CR><LF> SQVB1?<CR><LF> (Mono model only)
SequenceModeVbinning1	I Enumeration	R/W	SQVB2	1: Hbinning = OFF 2: Hbinning = ON	1	2	1	**SQVB2**=[Param.]<CR><LF> SQVB2?<CR><LF> (Mono model only)
SequenceModeVbinning2	I Enumeration	R/W	SQVB3	1: Hbinning = OFF 2: Hbinning = ON	1	2	1	**SQVB3**=[Param.]<CR><LF> SQVB3?<CR><LF> (Mono model only)
SequenceModeVbinning3	I Enumeration	R/W	SQVB4	1: Hbinning = OFF 2: Hbinning = ON	1	2	1	**SQVB4**=[Param.]<CR><LF> SQVB4?<CR><LF> (Mono model only)
SequenceModeVbinning4	I Enumeration	R/W	SQVB5	1: Hbinning = OFF 2: Hbinning = ON	1	2	1	**SQVB5**=[Param.]<CR><LF> SQVB5?<CR><LF> (Mono model only)
SequenceModeVbinning5	I Enumeration	R/W	SQVB6	1: Hbinning = OFF 2: Hbinning = ON	1	2	1	**SQVB6**=[Param.]<CR><LF> SQVB6?<CR><LF> (Mono model only)
SequenceModeVbinning6	I Enumeration	R/W	SQVB7	1: Hbinning = OFF 2: Hbinning = ON	1	2	1	**SQVB7**=[Param.]<CR><LF> SQVB7?<CR><LF> (Mono model only)
SequenceModeVbinning7	I Enumeration	R/W	SQVB8	1: Hbinning = OFF 2: Hbinning = ON	1	2	1	**SQVB8**=[Param.]<CR><LF> SQVB8?<CR><LF> (Mono model only)

SequenceMode Vbinning8	I Enumeration	R/W	SQVB9	1: Hbinning = OFF 2: Hbinning = ON	1	2	1	**SQVB9**=[Param.]<CR><LF> SQVB9?<CR><LF> (Mono model only)
SequenceMode Vbinning9	I Enumeration	R/W	SQVB10	1: Hbinning = OFF 2: Hbinning = ON	1	2	1	**SQVB10**=[Param.]<CR><LF> SQVB10?<CR><LF> (Mono model only)
SequenceMode LutEnable0	I Enumeration	R/W	SQLUT1	Off/On	0	1	0	**SQLUT1**=[Param.]<CR><LF> SQLUT1?<CR><LF>
SequenceMode LutEnable1	I Enumeration	R/W	SQLUT2	Off/On	0	1	0	**SQLUT2**=[Param.]<CR><LF> SQLUT2?<CR><LF>
SequenceMode LutEnable2	I Enumeration	R/W	SQLUT3	Off/On	0	1	0	**SQLUT3**=[Param.]<CR><LF> SQLUT3?<CR><LF>
SequenceMode LutEnable3	I Enumeration	R/W	SQLUT4	Off/On	0	1	0	**SQLUT4**=[Param.]<CR><LF> SQLUT4?<CR><LF>
SequenceMode LutEnable4	I Enumeration	R/W	SQLUT5	Off/On	0	1	0	**SQLUT5**=[Param.]<CR><LF> SQLUT5?<CR><LF>
SequenceMode LutEnable5	I Enumeration	R/W	SQLUT6	Off/On	0	1	0	**SQLUT6**=[Param.]<CR><LF> SQLUT6?<CR><LF>
SequenceMode LutEnable6	I Enumeration	R/W	SQLUT7	Off/On	0	1	0	**SQLUT7**=[Param.]<CR><LF> SQLUT7?<CR><LF>
SequenceMode LutEnable7	I Enumeration	R/W	SQLUT8	Off/On	0	1	0	**SQLUT8**=[Param.]<CR><LF> SQLUT8?<CR><LF>
SequenceMode LutEnable8	I Enumeration	R/W	SQLUT9	Off/On	0	1	0	**SQLUT9**=[Param.]<CR><LF> SQLUT9?<CR><LF>
SequenceMode LutEnable9	I Enumeration	R/W	SQLUT10	Off/On	0	1	0	**SQLUT10**=[Param.]<CR><LF> SQLUT10?<CR><LF>
SequenceMode BlackLevel0	I Integer	R/W	SQBL1	Min～Max	-256	255	0	**SQBL1**=[Param.]<CR><LF> SQBL1?<CR><LF>
SequenceMode BlackLevel1	I Integer	R/W	SQBL2	Min～Max	-256	255	0	**SQBL2**=[Param.]<CR><LF> SQBL2?<CR><LF>
SequenceMode BlackLevel2	I Integer	R/W	SQBL3	Min～Max	-256	255	0	**SQBL3**=[Param.]<CR><LF> SQBL3?<CR><LF>
SequenceMode BlackLevel3	I Integer	R/W	SQBL4	Min～Max	-256	255	0	**SQBL4**=[Param.]<CR><LF> SQBL4?<CR><LF>
SequenceMode BlackLevel4	I Integer	R/W	SQBL5	Min～Max	-256	255	0	**SQBL5**=[Param.]<CR><LF> SQBL5?<CR><LF>
SequenceMode BlackLevel5	I Integer	R/W	SQBL6	Min～Max	-256	255	0	**SQBL6**=[Param.]<CR><LF> SQBL6?<CR><LF>
SequenceMode BlackLevel6	I Integer	R/W	SQBL7	Min～Max	-256	255	0	**SQBL7**=[Param.]<CR><LF> SQBL7?<CR><LF>
SequenceMode BlackLevel7	I Integer	R/W	SQBL8	Min～Max	-256	255	0	**SQBL8**=[Param.]<CR><LF> SQBL8?<CR><LF>

SequenceMode BlackLevel8	I Integer	R/W	SQBL9	Min～Max	-256	255	0	**SQBL9**=[Param.]<CR><LF> SQBL9?<CR><LF>
SequenceMode BlackLevel9	I Integer	R/W	SQBL10	Min～Max	-256	255	0	**SQBL10**=[Param.]<CR><LF> SQBL10?<CR><LF>
SequenceMode GainRed0	I Integer	R/W	SQPGR1	Min～Max	-4533	17713	0	**SQPGR1**=[Param.]<CR><LF> SQPGR1?<CR><LF> (Bayer model only)
SequenceMode GainRed1	I Integer	R/W	SQPGR2	Min～Max	-4533	17713	0	**SQPGR2**=[Param.]<CR><LF> SQPGR2?<CR><LF> (Bayer model only)
SequenceMode GainRed2	I Integer	R/W	SQPGR3	Min～Max	-4533	17713	0	**SQPGR3**=[Param.]<CR><LF> SQPGR3?<CR><LF> (Bayer model only)
SequenceMode GainRed3	I Integer	R/W	SQPGR4	Min～Max	-4533	17713	0	**SQPGR4**=[Param.]<CR><LF> SQPGR4?<CR><LF> (Bayer model only)
SequenceMode GainRed4	I Integer	R/W	SQPGR5	Min～Max	-4533	17713	0	**SQPGR5**=[Param.]<CR><LF> SQPGR5?<CR><LF> (Bayer model only)
SequenceMode GainRed5	I Integer	R/W	SQPGR6	Min～Max	-4533	17713	0	**SQPGR6**=[Param.]<CR><LF> SQPGR6?<CR><LF> (Bayer model only)
SequenceMode GainRed6	I Integer	R/W	SQPGR7	Min～Max	-4533	17713	0	**SQPGR7**=[Param.]<CR><LF> SQPGR7?<CR><LF> (Bayer model only)
SequenceMode GainRed7	I Integer	R/W	SQPGR8	Min～Max	-4533	17713	0	**SQPGR8**=[Param.]<CR><LF> SQPGR8?<CR><LF> (Bayer model only)
SequenceMode GainRed8	I Integer	R/W	SQPGR9	Min～Max	-4533	17713	0	**SQPGR9**=[Param.]<CR><LF> SQPGR9?<CR><LF> (Bayer model only)
SequenceMode GainRed9	I Integer	R/W	SQPGR10	Min～Max	-4533	17713	0	**SQPGR10**=[Param.]<CR><LF> SQPGR10?<CR><LF> (Bayer model only)
SequenceMode GainBlue0	I Integer	R/W	SQPGB1	Min～Max	-4533	17713	0	**SQPGB1**=[Param.]<CR><LF> SQPGB1?<CR><LF> (Bayer model only)
SequenceMode GainBlue1	I Integer	R/W	SQPGB2	Min～Max	-4533	17713	0	**SQPGB2**=[Param.]<CR><LF> SQPGB2?<CR><LF> (Bayer model only)
SequenceMode GainBlue2	I Integer	R/W	SQPGB3	Min～Max	-4533	17713	0	**SQPGB3**=[Param.]<CR><LF> SQPGB3?<CR><LF> (Bayer model only)
SequenceMode GainBlue3	I Integer	R/W	SQPGB4	Min～Max	-4533	17713	0	**SQPGB4**=[Param.]<CR><LF> SQPGB4?<CR><LF>

								(Bayer model only)
SequenceModeGainBlue4	I Integer	R/W	SQPGB5	Min～Max	-4533	17713	0	**SQPGB5**=[Param.]<CR><LF> SQPGB5?<CR><LF> (Bayer model only)
SequenceModeGainBlue5	I Integer	R/W	SQPGB6	Min～Max	-4533	17713	0	**SQPGB6**=[Param.]<CR><LF> SQPGB6?<CR><LF> (Bayer model only)
SequenceModeGainBlue6	I Integer	R/W	SQPGB7	Min～Max	-4533	17713	0	**SQPGB7**=[Param.]<CR><LF> SQPGB7?<CR><LF> (Bayer model only)
SequenceModeGainBlue7	I Integer	R/W	SQPGB8	Min～Max	-4533	17713	0	**SQPGB8**=[Param.]<CR><LF> SQPGB8?<CR><LF> (Bayer model only)
SequenceModeGainBlue8	I Integer	R/W	SQPGB9	Min～Max	-4533	17713	0	**SQPGB9**=[Param.]<CR><LF> SQPGB9?<CR><LF> (Bayer model only)
SequenceModeGainBlue9	I Integer	R/W	SQPGB10	Min～Max	-4533	17713	0	**SQPGB10**=[Param.]<CR><LF> SQPGB10?<CR><LF> (Bayer model only)
CommnadSequenceIndex	I Enumeration	R/W	SQI	Same as SequenceModeIndex	0	9	0	**CSQI**=[Param.]<CR><LF> CSQI?<CR><LF>
CurrentSequenceIndex	I Enumeration	R/O	SQIDX	Same as SequenceModeIndex	0	9	0	**SQIDX**?<CR><LF>
SequenceReset	I Enumeration	W/O	SQRST	0	0	0	0	**SQRST**=[Param.]<CR><LF>
SequenceLutMode	I Enumeration	R/W	SQLUT	0: Gamma 1: LUT	0	1	0	**SQLUT**=[Param.]<CR><LF> SQLUT?<CR><LF>
LUTMode	I Enumeration	R/W	LUTC	0: Off 1: Gamma 2: LUT	0	2	0	**LUTC**=[Param.]<CR><LF> LUTC?<CR><LF>
AlcSpeed	I Integer	R/W	ALCS	Min～Max	1	8	4	**ALCS**=[Param.]<CR><LF> ALCS?<CR><LF> for AGC and ASC
ExposureAutoMax	I Integer	R/W	ASCEA	Min～Max[us]	101	800000	18000	**ASCEA**=[Param.]<CR><LF> ASCEA?<CR><LF> Maximum value is varied depending on frame rate.
ExposureAutoMin	I Integer	R/W	ASCEI	Min～Max	100	799999	100	**ASCEI**=[Param.]<CR><LF> ASCEI?<CR><LF> Maximum value is varied depending on frame rate.
RequestExposureAutoResult	I Enumeration	R/O	ASRS	0=Complete. 1=Too Bright. 2=Too dark. 3=Timeout Error. 4=Busy.	0	6	0	**ASRS?<CR><LF>**

				5=Limit. 6= Trig is not set as Normal.				
TriggerOption	I Enumeration	R/W	TRGOP	0: Off 1: RCT 2: PIV 3: Smear-less 4: RCT Continuous	0	4	0	**TRGOP**=[Param.]<CR><LF> TRGOP?<CR><LF>
AlcReference	I Integer	R/W	AGCF	Min～Max[%]	1	100	50	**AGCF**=[Param.]<CR><LF> AGCF?<CR><LF>
GainAutoMax	I Integer	R/W	AGCGA	Min～Max	0	672	672	**AGCGA**=[Param.]<CR><LF> AGCGA?<CR><LF>
GainAutoMin	I Integer	R/W	AGCGI	Min～Max	-84 (Mono) 0 (Bayer)	671	0	**AGCGI**=[Param.]<CR><LF> AGCGI?<CR><LF>
RequestGainAuto Result	I Enumeration	R/O	AGRS	0=Complete. 1=Too Bright. 2=Too dark. 3=Timeout Error. 4=Busy. 5=Limit. 6= Trig is not set as Normal.	0	6	0	**AGRS?<CR><LF>**
AutoIrisLensControl SignalOutput	I Enumeration	R/W	AIC	0: Off 1: On	0	1	0	**AIC**=[Param.]<CR><LF> AIC?<CR><LF>
LensSelect	I Enumeration	R/W	AIS	0: None 1: P-IRIS Lens 2: MOTOR Iris Lens 3: Video Iris Lens 4: DC Iris Lens	0	4	0	**AIS**=[Param.]<CR><LF> AIS?<CR><LF>
VideoIrisState Control	I Enumeration	R/W	ISC	0: Video 1: Close 2: Open	0	1	2	**ISC**=[Param.]<CR><LF> ISC?<CR><LF>
ALCChannelAreaAll	I Enumeration	R/W	ALCA	0: Off / 1: On	0	1	0	**ALCA**=[Param.]<CR><LF> ALCA?<CR><LF>
ALCChannelArea LowRight	I Enumeration	R/W	ALCLR	0: Off / 1: On	0	1	1	**ALC****=[Param.]<CR><LF> ALC**?<CR><LF>
ALCChannelArea LowMidRight	I Enumeration	R/W	ALCLMR	0: Off / 1: On	0	1	1	
ALCChannelArea LowMidLeft	I Enumeration	R/W	ALCLML	0: Off / 1: On	0	1	1	
ALCChannelArea LowLeft	I Enumeration	R/W	ALCLL	0: Off / 1: On	0	1	1	
ALCChannelArea MidLowRight	I Enumeration	R/W	ALCMLR	0: Off / 1: On	0	1	1	
ALCChannelArea MidLowMidRight	I Enumeration	R/W	ALCMLMR	0: Off / 1: On	0	1	1	
ALCChannelArea MidLowMidLeft	I Enumeration	R/W	ALCMLML	0: Off / 1: On	0	1	1	

ALCChannelArea MidLowLeft	I Enumeration	R/W	ALCMLL	0: Off / 1: On	0	1	1	
ALCChannelArea MidHighRight	I Enumeration	R/W	ALCMHR	0: Off / 1: On	0	1	1	
ALCChannelArea MidHighMidRight	I Enumeration	R/W	ALCMHMR	0: Off / 1: On	0	1	1	
ALCChannelArea MidHighMidLeft	I Enumeration	R/W	ALCMHML	0: Off / 1: On	0	1	1	
ALCChannelArea MidHighLeft	I Enumeration	R/W	ALCMHL	0: Off / 1: On	0	1	1	
ALCChannelArea HighRight	I Enumeration	R/W	ALCHR	0: Off / 1: On	0	1	1	
ALCChannelArea HighMidRight	I Enumeration	R/W	ALCHMR	0: Off / 1: On	0	1	1	
ALCChannelArea HighMidLeft	I Enumeration	R/W	ALCHML	0: Off / 1: On	0	1	1	
ALCChannelArea HighLeft	I Enumeration	R/W	ALCHL	0: Off / 1: On	0	1	1	
AWBChannelAreaAll	I Enumeration	R/W	AWBA	0: Off / 1: On	0	1	0	**AWB****=[Param.]<CR><LF> AWB**?<CR><LF> (Bayer model only)
AWBChannelArea LowRight	I Enumeration	R/W	AWBLR	0: Off / 1: On	0	1	1	
AWBChannelArea LowMidRight	I Enumeration	R/W	AWBLMR	0: Off / 1: On	0	1	1	
AWBChannelArea LowMidLeft	I Enumeration	R/W	AWBLML	0: Off / 1: On	0	1	1	
AWBChannelArea LowLeft	I Enumeration	R/W	AWBLL	0: Off / 1: On	0	1	1	
AWBChannelArea MidLowRight	I Enumeration	R/W	AWBMLR	0: Off / 1: On	0	1	1	
AWBChannelArea MidLowMidRight	I Enumeration	R/W	AWBMLMR	0: Off / 1: On	0	1	1	
AWBChannelArea MidLowMidLeft	I Enumeration	R/W	AWBMLML	0: Off / 1: On	0	1	1	
AWBChannelArea MidLowLeft	I Enumeration	R/W	AWBMLL	0: Off / 1: On	0	1	1	
AWBChannelArea MidHighRight	I Enumeration	R/W	AWBMHR	0: Off / 1: On	0	1	1	

AWBChannelArea MidHighMidRight	I Enumeration	R/W	AWBMHMR	0: Off / 1: On	0	1	1	
AWBChannelArea MidHighMidLeft	I Enumeration	R/W	AWBMHML	0: Off / 1: On	0	1	1	
AWBChannelArea MidHighLeft	I Enumeration	R/W	AWBMHL	0: Off / 1: On	0	1	1	
AWBChannelArea HighRight	I Enumeration	R/W	AWBHR	0: Off / 1: On	0	1	1	
AWBChannelArea HighMidRight	I Enumeration	R/W	AWBHMR	0: Off / 1: On	0	1	1	
AWBChannelArea HighMidLeft	I Enumeration	R/W	AWBHML	0: Off / 1: On	0	1	1	
AWBChannelArea HighLeft	I Enumeration	R/W	AWBHL	0: Off / 1: On	0	1	1	
RequestBalanceWhite AutoResult	I Enumeration	R/O	AWRS	0=Complete. 1=Too Bright. 2=Too dark. 3=Timeout Error. 4=Busy. 5=Limit. 6= Trig is not set as Normal.	0	6	0	**AWRS**?<CR><LF> (Bayer model only)
CurrentAreaNoRequest	I Integer	R/O	EA	0: Factory area 1: User 1 area 2: User 2 area 3: User 3 area	0	3	0	**EA**?<CR><LF> The camera return the latest used DATA AREA.
PirisLensSelect	I Enumeration	R/W	PLS	0: LM16JC5MM 1: LM35JC5MM	0	1	0	**PLS**=[Param.]<CR><LF> PLS?<CR><LF>
PIrisStepMax	I Integer	R/O	PIS	Indicate P-IRIS control step maximum value	0	255	128	**PIS**?<CR><LF> Different depending on PirisLensSelect value
PIrisPosition	I Integer	R/W	PIP	Min～Max	0	255	128	**PIP**=[Param.]<CR><LF> PIP?<CR><LF> Maximum value is PIrisStepMax
PirisAutoMin	I Enumeration	R/W	PLI	0: FULL OPEN 1: F1.4 2: F2 3: F2.8 4: F4 5: F5.6 6: F8 7: F11 8: F16 9: F22 10: F32 11: CLOSE	0	11	1	**PLI**=[Param.]<CR><LF> PLI?<CR><LF> Minimum value and Maximum value are different depending on PirisLensSelect value
PirisAutoMax	I Enumeration	R/W	PLA	Same as above.	0	11	5	**PLI**=[Param.]<CR><LF> PLI?<CR><LF>

								Minimum value and Maximum value are different depending on PirisLensSelect value
PirisCurrentFvalue	I Enumeration	R/O	PCV	Same as above.	0	11	0	**PCV**?<CR><LF>
AcquisitionFrameLine	I Integer	R/W	AR	Min～Max	1	325786	774	**AR**=[Param.]<CR><LF> AR?<CR><LF> Maximum value is calcurated depending on Height and Offset Y settings
GammaSelector	I Integer	R/W	GMA	0(γ=1) ～ 8(γ=0.45) ～15(γ=TBD)	0	15	8	**GMA**=[Param.]<CR><LF> GMA?<CR><LF>
Temperature	I Integer	R/O	TMP0	value	—	—	—	**TMP0**?<CR><LF> (Value÷128) = Temperature[℃]
GpioPulseGen Divide Value	I Integer	R/W	PGDEV	Min～Max	1	4096	1	**PGDEV**=[Param.]<CR><LF> PGDEV?<CR><LF>
GpioPulseGen Length0	I Integer	R/W	PGL0	Min～Max	1	1048575	1	**PGL0**=[Param.]<CR><LF> PGL0?<CR><LF>
GpioPulseGen Length1	I Integer	R/W	PGL1	Min～Max	1	1048575	1	**PGL1**=[Param.]<CR><LF> PGL1?<CR><LF>
GpioPulseGen Length2	I Integer	R/W	PGL2	Min～Max	1	1048575	1	**PGL2**=[Param.]<CR><LF> PGL2?<CR><LF>
GpioPulseGen Length3	I Integer	R/W	PGL3	Min～Max	1	1048575	1	**PGL3**=[Param.]<CR><LF> PGL3?<CR><LF>
GpioPulseGenStart Point0	I Integer	R/W	PGST0	Min～Max	0	1048574	0	**PGST0**=[Param.]<CR><LF> PGST0?<CR><LF>
GpioPulseGenStart Point1	I Integer	R/W	PGST1	Min～Max	0	1048574	0	**PGST1**=[Param.]<CR><LF> PGST1?<CR><LF>
GpioPulseGenStart Point2	I Integer	R/W	PGST2	Min～Max	0	1048574	0	**PGST2**=[Param.]<CR><LF> PGST2?<CR><LF>
GpioPulseGenStart Point3	I Integer	R/W	PGST3	Min～Max	0	1048574	0	**PGST3**=[Param.]<CR><LF> PGST3?<CR><LF>
GpioPulseGen End Point0	I Integer	R/W	PGEN0	Min～Max	1	1048575	1	**PGEN0**=[Param.]<CR><LF> PGEN0?<CR><LF>
GpioPulseGen End Point1	I Integer	R/W	PGEN1	Min～Max	1	1048575	1	**PGEN1**=[Param.]<CR><LF> PGEN1?<CR><LF>
GpioPulseGen End Point2	I Integer	R/W	PGEN2	Min～Max	1	1048575	1	**PGEN2**=[Param.]<CR><LF> PGEN2?<CR><LF>
GpioPulseGen End Point3	I Integer	R/W	PGEN3	Min～Max	1	1048575	1	**PGEN3**=[Param.]<CR><LF> PGEN3?<CR><LF>
GpioPulseGen Repeat Count0	I Integer	R/W	PGRPT0	Min～Max	0	255	0	**PGRPT0**=[Param.]<CR><LF>

								PGRPT0?<CR><LF>
GpioPulseGen Repeat Count1	I Integer	R/W	PGRPT 1	Min～Max	0	255	0	**PGRPT1**=[Param.]<CR><LF> PGRPT1?<CR><LF>
GpioPulseGen Repeat Count2	I Integer	R/W	PGRPT 2	Min～Max	0	255	0	**PGRPT2**=[Param.]<CR><LF> PGRPT2?<CR><LF>
GpioPulseGen Repeat Count3	I Integer	R/W	PGRPT 3	Min～Max	0	255	0	**PGRPT3**=[Param.]<CR><LF> PGRPT3?<CR><LF>
GpioPulseGen Clear Mode0	I Enumeration	R/W	PGCM 0	0: Free Run 1: Level High 2: Level Low 3: Rising Edge 4: Falling Edge	0	4	0	**PGCM0**=[Param.]<CR><LF> PGCM0?<CR><LF>
GpioPulseGen Clear Mode1	I Enumeration	R/W	PGCM 1	Same as above.	0	4	0	**PGCM1**=[Param.]<CR><LF> PGCM1?<CR><LF>
GpioPulseGen Clear Mode2	I Enumeration	R/W	PGCM 2	Same as above.	0	4	0	**PGCM2**=[Param.]<CR><LF> PGCM2?<CR><LF>
GpioPulseGen Clear Mode3	I Enumeration	R/W	PGCM 3	Same as above.	0	4	0	**PGCM3**=[Param.]<CR><LF> PGCM3?<CR><LF>
GpioPulseGenSync Mode0	I Enumeration	R/W	PGSM0	0: Async Mode 1: Sync Mode	0	1	0	**PGSM0**=[Param.]<CR><LF> PGSM0?<CR><LF>
GpioPulseGenSync Mode1	I Enumeration	R/W	PGSM1	Same as above.	0	1	0	**PGSM1**=[Param.]<CR><LF> PGSM1?<CR><LF>
GpioPulseGenSync Mode2	I Enumeration	R/W	PGSM2	Same as above.	0	1	0	**PGSM2**=[Param.]<CR><LF> PGSM2?<CR><LF>
GpioPulseGenSync Mode3	I Enumeration	R/W	PGSM3	Same as above.	0	1	0	**PGSM3**=[Param.]<CR><LF> PGSM3?<CR><LF>
GpioPulseGenInput0	I Enumeration	R/W	PGIN0	0:Low 1:High 2:Soft 3:AcquisitionTriggerWait 4:FrameTriggerWait 5:FrameActive 6:ExposureActive 7:FVAL 8:LVAL 9:PG0 10:PG1 11:PG2 12:PG3 13: TTL in 14:CL CC1 in 15:nand0 16:nand1 17: OPTTL in2 18: OPLVDS in	0	18	0	**PGIN0**=[Param.]<CR><LF> PGIN0?<CR><LF>
GpioPulseGenInput1	I Enumera	R/W	PGIN1	Same as above.	0	18	0	**PGIN1**=[Param.]<CR><LF>

	tion							PGIN1?<CR><LF>
GpioPulseGenInput2	I Enumeration	R/W	PGIN2	Same as above.	0	18	0	**PGIN2**=[Param.]<CR><LF> PGIN2?<CR><LF>
GpioPulseGenInput3	I Enumeration	R/W	PGIN3	Same as above.	0	18	0	**PGIN3**=[Param.]<CR><LF> PGIN3?<CR><LF>
GpioPulseGenInvert0	I Enumeration	R/W	PGINV0	0:Non-Inv 1:Inv	0	1	0	**PGIN0**=[Param.]<CR><LF> PGIN0?<CR><LF>
GpioPulseGenInvert1	I Enumeration	R/W	PGINV1	Same as above.	0	1	0	**PGIN1**=[Param.]<CR><LF> PGIN1?<CR><LF>
GpioPulseGenInvert2	I Enumeration	R/W	PGINV2	Same as above.	0	1	0	**PGIN2**=[Param.]<CR><LF> PGIN2?<CR><LF>
GpioPulseGenInvert3	I Enumeration	R/W	PGINV3	Same as above.	0	1	0	**PGIN3**=[Param.]<CR><LF> PGIN3?<CR><LF>
GpioNand0InputSource1	I Enumeration	R/W	ND0IN1	0: Low 1: High 2: FrameTriggerWait 3: FramActive 4: ExposureActive 5: Fval 6: PulseGenerator0 7: PulseGenerator1 8: PulseGenerator2 9: PulseGenerator3 10: TTL_In1 11: CL_CC1_In	0	11	0	**ND0N1**=[Param.]<CR><LF> ND0IN1?<CR><LF>
GpioNand1InputSource1	I Enumeration	R/W	ND1IN1	Same as above.	0	11	0	**ND1N1**=[Param.]<CR><LF> ND1IN1?<CR><LF>
GpioNand0InputSource2	I Enumeration	R/W	ND0IN2	0: Low 1: High 2: FrameTriggerWait 3: FramActive 4: ExposureActive 5: Fval 6: PulseGenerator0 7: PulseGenerator1 8: PulseGenerator2 9: PulseGenerator3 10: TTL_In1 11: CL_CC1_In	0	11	0	**ND0N2**=[Param.]<CR><LF> ND0IN2?<CR><LF>
GpioNand1InputSource2	I Enumeration	R/W	ND1IN2	Same as above.	0	11	0	**ND1N2**=[Param.]<CR><LF> ND1IN2?<CR><LF>
GpioNand0InputInvert1	I Enumeration	R/W	ND0INV1	0: Non-Inv 1: Inv	0	1	0	**ND0INV1**=[Param.]<CR><LF> ND0INV1?<CR><LF>
GpioNand1InputInvert1	I Enumeration	R/W	ND1INV1	Same as above.	0	1	0	**ND1INV1**=[Param.]<CR><LF> ND1INV1?<CR><LF>
GpioNand0InputInvert2	I Enumeration	R/W	ND0INV2	0: Non-Inv 1: Inv	0	1	0	**ND0INV2**=[Param.]<CR><LF> ND0INV2?<CR><LF>

GpioNand1InputInvert2	I Enumeration	R/W	ND1INV2	Same as above.	0	1	0	**ND1INV2**=[Param.]<CR><LF> ND1INV2?<CR><LF>
MotorLensIris	I Enumeration	R/W	MLI	0: Stop 1: Open 2: Close	0	2	0	**MLI**=[Param.]<CR><LF> MLI?<CR><LF>
MotorLensZoom	I Enumeration	R/W	MLZ	0: Stop 1: Wide 2: Tele	0	2	0	**MLZ**=[Param.]<CR><LF> MLZ?<CR><LF>
MotorLensFocus	I Enumeration	R/W	MLF	0: Stop 1: Wide 2: Tele	0	2	0	**MLF**=[Param.]<CR><LF> MLF?<CR><LF>
LUTSequenceR	I Enumeration	R/W	LUTSR	Min～Max	0	4095	0	**LUTSR**=[Param.]<CR><LF> LUTSR?<CR><LF>
LUTSequenceG	I Enumeration	R/W	LUTSG	Min～Max	0	4095	0	**LUTSG**=[Param.]<CR><LF> LUTSG?<CR><LF>
LUTSequenceB	I Enumeration	R/W	LUTSB	Min～Max	0	4095	0	**LUTSB**=[Param.]<CR><LF> LUTSB?<CR><LF>
Request BalanceAutoResult	I Enumeration	R/O	WBRS	0=Complete. 1=Too Bright. 2=Too dark. 3=Timeout Error. 4=Busy. 5=Limit. 6= Trig is not set as Normal.	0	6	0	**BRFS**?<CR><LF>
RequestBlack BalanceAutoResult	I Enumeration	R/O	BBRS	0=Complete. 1=Too Bright. 2=Too dark. 3=Timeout Error. 4=Busy. 5=Limit. 6= Trig is not set as Normal.	0	6	0	**BBRS?**<CR><LF>
BlemishNum	I Integer	R/O	BNUM	Min～Max	0	512	0	**BNUM?**<CR><LF>

Appendix 2

1. Precautions

Personnel not trained in dealing with similar electronic devices should not service this camera. The camera contains components sensitive to electrostatic discharge. The handling of these devices should follow the requirements of electrostatic sensitive components.
Do not attempt to disassemble this camera.
Do not expose this camera to rain or moisture.
Do not face this camera towards the sun, extreme bright light or light reflecting objects.
When this camera is not in use, put the supplied lens cap on the lens mount.
Handle this camera with the maximum care.
Operate this camera only from the type of power source indicated on the camera.
Power off the camera during any modification such as changes of jumper and switch setting.

2. Typical Sensor Characteristics

The following effects may be observed on the video monitor screen. They do not indicate any fault of the camera, but are associated with typical sensor characteristics.

V. Aliasing

When the CCD camera captures stripes, straight lines or similar sharp patterns, jagged edges may appear on the monitor.

Blemishes

All cameras are shipped without visible image sensor blemishes.
Over time some pixel defects can occur. This does not have a practical effect on the operation of the camera. These will show up as white spots (blemishes).
Exposure to cosmic rays can cause blemishes to appear on the image sensor. Please take care to avoid exposure to cosmic rays during transportation and storage. It is recommended using sea shipment instead of air flight in order to limit the influence of cosmic rays on the camera. Pixel defects/blemishes also may emerge due to prolonged operation at elevated ambient temperature, due to high gain setting, or during long time exposure. It is therefore recommended to operate the camera within its specifications.

Patterned Noise

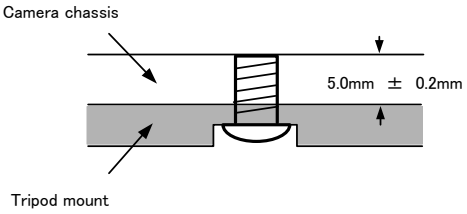
When the sensor captures a dark object at high temperature or is used for long time integration, fixed pattern noise may appear on the video monitor screen.

3. Caution when mounting a lens on the camera

When mounting a lens on the camera dust particles in the air may settle on the surface of the lens or the image sensor of the camera. It is therefore important to keep the protective caps on the lens and on the camera until the lens is mounted. Point the lens mount of the camera downward to prevent dust particles from landing on the optical surfaces of the camera. This work should be done in a dust free environment. Do not touch any of the optical surfaces of the camera or the lens.

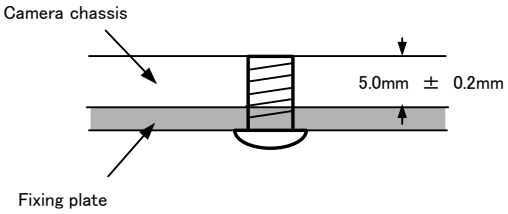
4. Caution when mounting the camera

When you mount the camera on your system, please make sure to use screws of the recommended length described in the following drawing. Longer screws may cause serious damage to the PCB inside the camera.



Attaching the tripod mount

If you mount the tripod mounting plate, please use the provided screws.



Mounting the camera to fixing plate

5. Exportation

When exporting this product, please follow the export regulation of your own country.

6. References

1. This manual and a datasheet for EL-2800M-PMCL / EL-2800C-PMCL can be downloaded from www.jai.com
2. JAI SDK software can be downloaded from www.jai.com

Manual change history

Date	Revision	Changes
June 2013	1.0	New release
July 2013	1.1	Correct typo in Table 2 and Table 3
July 2013	1.2	Change the description of AUX connectors
Aug. 2013	1.3	Revised specifications SNR and sensitivity, Add EMVA 1288 measurement specifications, Correct timing figures
Aug. 2013	1.4	Add Short ASCII Command Protocol as the reference
Oct. 2013	1.5	Add EMVA1288 spec. for EL-2800C^PMCL

See the possibilities

User's Record

Camera type: **EL-2800M-PMCL / EL-2800C-PMCL**

Revision: ……..

Serial No. ……..

Firmware version. ……..

For camera revision history, please contact your local JAI distributor.

User's Mode Settings.

User's Modifications.

Europe, Middle East & Africa	*Asia Pacific*	*Americas*
Phone +45 4457 8888 *Fax +45 4491 3252*	*Phone +81 45 440 0154* *Fax +81 45 440 0166*	*Phone (toll-free) +1 800 445 5444* *Phone +1 408 383 0300*

Visit our web site at www.jai.com

See the possibilities